FIREBERD 2000

DATA ERROR ANALYZER

OPERATING MANUAL

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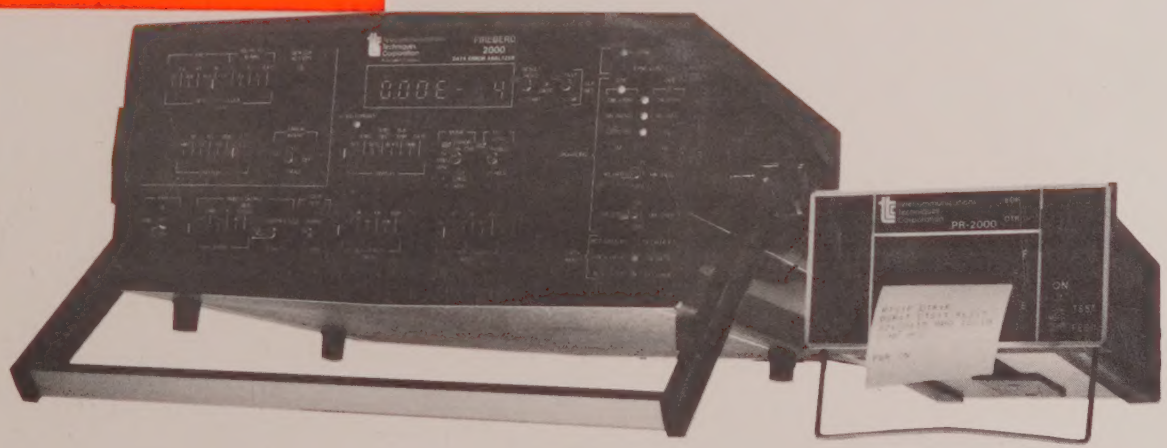

Telecommunications Techniques Corporation T.M. A DYNATECH CO.

EXPECT EXCELLENCE

ML 10220
Revision A

FIREBERD 2000
OPERATING MANUAL

December 1983

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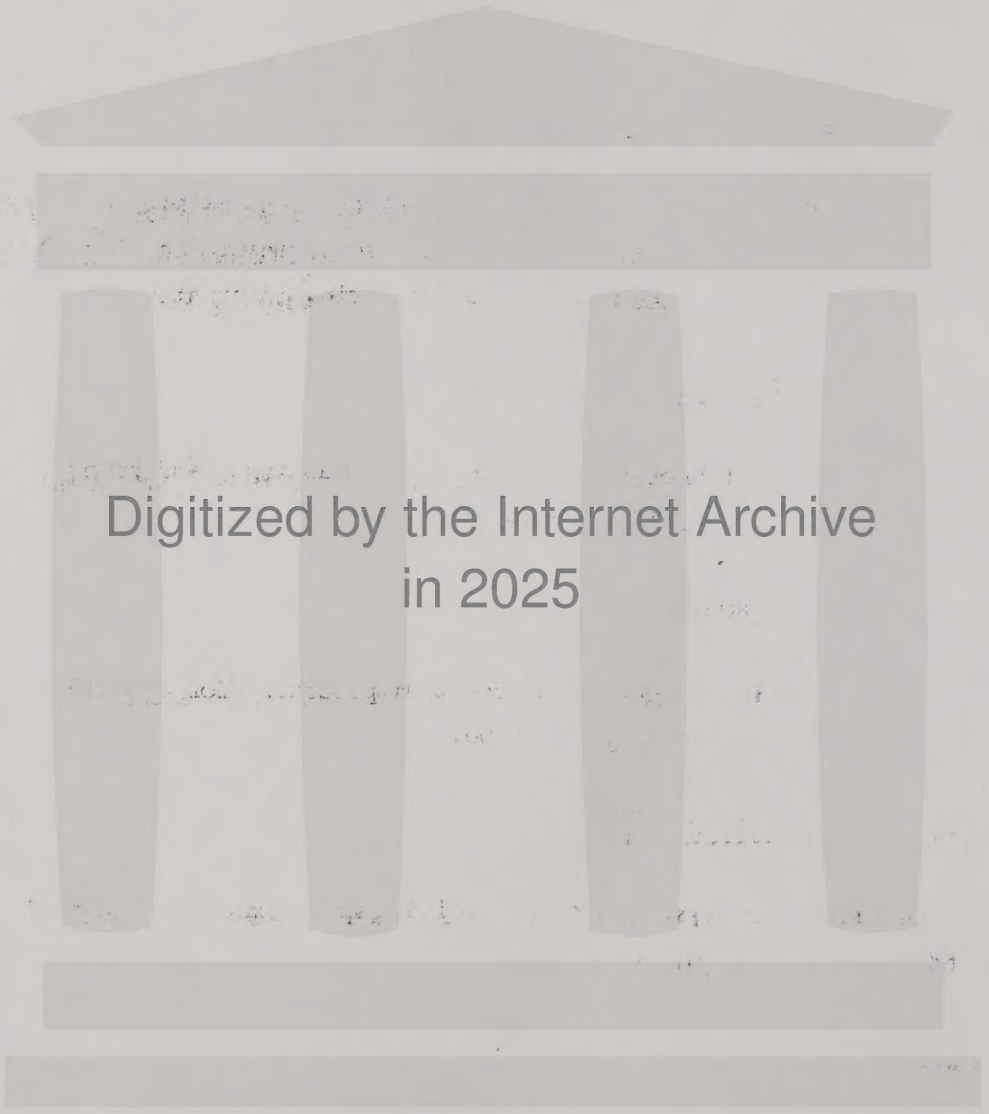
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MANUAL ABSTRACT

This Operating Manual comprises eight sections and one appendix. Each manual section is briefly described below.

Section 1 GENERAL INFORMATION

This section contains general information relating to the FIREBERD 2000 including: instrument identification, specifications, instrument description, equipment supplied, options, accessories, and ordering information.

Section 2 PREPARATION FOR USE

Unpacking and initial inspection instructions, warnings, and power requirements are contained in this section.

Section 3 INSTRUMENT CHECKOUT

This section provides an instrument checkout procedure for manually checking the operation of the FIREBERD 2000.

Section 4 INSTRUMENT DESCRIPTION

A detailed description of each control, indicator, connector and test point on the instrument is provided.

Section 5 OPERATION

This section contains operating information including: measurement capability, measurement configurations, operating considerations, and an operating procedure.

Section 6 PRINTER INTERFACES AND PRINTOUT FORMATS

This section describes events which initiate data outputs, data output formats, and data buffering for the RS-232 and IEEE-488 Printer Interfaces. A physical and signal format description for the RS-232 interface is also provided. Information related to remote control of the FIREBERD 2000 via the RS-232 or IEEE-488 interfaces (option 007 and 008) is not provided in this manual but is provided in a separate manual, Number ML 10491.

Section 7 INTERFACE ADAPTOR MODULES

Descriptions, specifications, and operating instructions are provided for 13 different Interface Adaptor Modules. Less frequently used Interface Adaptors are described in separate, individual manuals.

Section 8 OPTIONS AND ACCESSORIES

Options and accessories available for use with the FIREBERD are described.

Section 9 MAINTENANCE AND SERVICE

Warranty, servicing, and shipping information are provided in this section.

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SECTION 1
GENERAL INFORMATION

1.1 INTRODUCTION

This Operating Manual contains information required to install and operate FIREBERD 2000 and FIREBERD M2000 Data Error Analyzers. The FIREBERD 2000 and the FIREBERD M2000 are electrically and functionally identical with differences only in mechanical packaging. The FIREBERD 2000 is packaged in a rugged plastic case with a swing-around handle and protective front cover. The FIREBERD M2000 is packaged in a slightly larger metal case with protective front and rear covers. In the remainder of this manual, references to the FIREBERD or FIREBERD 2000 also apply to the FIREBERD M2000 unless otherwise indicated.

1.2 INSTRUMENT IDENTIFICATION

An identification sticker is attached to the rear panel of each instrument. The serial number on this plate should be quoted on any correspondence with TTC.

1.3 SPECIFICATIONS

a. Test Patterns:	Pseudornadom sequences of length 63, 511, 2047, 2^{15}-1, and 2^{20}-1. Constant mark, constant space, and 1:3 (1 mark followed by 3 spaces...)

b. Operating Rate

Error Analysis:	100 Hz to 10 MHz*
Frequency Measurement:	200 Hz to 13 MHz

c. Internal Standard Clock

Frequencies:	1.2, 2.4, 4.8, 9.6, 19.2, 56, and 64 KHz
Accuracy:	± 1 ppm at 25°C
Stability:	1 ppm 0 to 40°C
Drift:	<1.5 ppm per year

d. Internal Optional Clock

Frequencies:	100 Hz to 10 MHz
Accuracy:	± 1 ppm at 25°C
Stability:	5 ppm 0 to 40°C
Drift:	5 ppm per year typical

e. Frequency Counter

Accuracy:	± 1 ppm ± 1 Hertz

f. External Clock Input (BNC)

Frequency:	50 Hz to 13 MHz
Waveform:	Sine or square wave, unipolar or bipolar
Level:	.6v pp to 25v pp

g. Measurements: BER, Errors, Blocks, Block Errors, Error-Seconds, Seconds of Test, Frequency, and Average BER

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*See Section 5.4.8.1 for operation below 100 Hz

h.	Real Time Clock Outputs:	Month, Day, Hour, Minute, and Second
i.	Block Lengths:	400, 1k, 4k, 10k, 40k, and 100k
j.	BER Test Length	
	Fixed Length:	10^5, 10^6, 10^7, 10^8, and 10^9
	Automatic:	10^5, 10^6, 10^7, 10^8, 10^9, 10^{10}, and 10^{11}
k.	BER Range	1 to 10^{-11} errors/bit
l.	Error Insertion	Single error or constant 10^{-3} error rate
m.	Events Initiating Printout:	Manual, Error, 1 min., 10 min., 30 min., BER Cycle, Sync Loss, Signaling Change (optional), Counter Overflow, Sync Acquisition, Power On, and Clock Loss
n.	Emulation Capability:	DTE or DCE
o.	Available Interfaces*:	RS-232 Sync DTE RS-232 Sync/Isoch DTE RS-232 Async (Character) DTE/DCE RS-232 Sync DTE/DCE

*Consult TTC for the latest list of available Interface Modules.

o.	Available Interfaces*: (Continued)	V.35/306 DTE V.35/306 DTE/DCE RS-449-422/423 DTE RS-449-422/423 DTE/DCE RS-449-422/423 Bridging DS1 (T1) WECO 303 LAB (TTL) Military-Mil-188-114 Unbalanced, Mil-188C Military-Mil-188-114 Balanced G.703 64 kbps Codirectional Timing
p.	Display Size:	7 Digits
q.	LED Indicators:	Sync, Sync Lost, Generator Clock Activity, RCV/TX Clock Activity, RCT/TX Data Activity, Data Invert, Power, DM (DSR)/TR (DTR), RR (RLSD)/RS (RTS), CS (CTS)/LL, TM/RL, Less Than 100 Errors, DTE, and DCE
r.	Input/Output Signals via Interface Modules:	TX Clock (DCE Source) TX Clock (DTE Source) TX Data, RCV Data, RCV Clock, RS (RTS), CS (CTS), TR (DTR), RR (RLSD), DM (DSR), TR, RL, and LL

*Consult TTC for the latest list of available Interface Modules.

s.	Signals at Rear Panel Test Points (TTL Levels):	TX Sync, RCV Sync, Error, Ground, RCV Clk, TX Clk (DTE Source), TX Clk (DCE Source), TX Data, and RCV Data
t.	Remote Control Capability (Optional):	Full remote control of all front panel switches (except power), printer device selection and interface switching unit port selection via the RS-232 or IEEE-488 interfaces. Additionally, the user gains the ability to store up to ten sets of front panel switch configurations in non-volitile memory for use at a later time.
u.	Size	
	Plastic Case:	6"H x 12"W x 12"D
	Metal Case:	7.6H (including feet) x 14.2W x 16.2D (with covers)
v.	Weight (approx.) with Interface Modules	
	Plastic Case:	10 lbs. (with cover)
	Metal Case:	18 lbs. (with cover)
w.	Power:	Switch selectable 100/120/220/240 VAC $\pm$ 10%, 48 to 66 Hz, 60 Volt-Amperes (maximum)
x.	Environmental:	0 to 50°C operating -40 to 85°C storage

1.4 DESCRIPTION

The FIREBERD 2000 is designed to aid in troubleshooting and evaluating digital communications systems. With the appropriate Interface Module, the FIREBERD may be used to test communication systems configured as either Data Terminal Equipment (DTE) or Data Communications Equipment (DCE). The instrument has a fully independent transmitter and receiver to allow loop-around or end-to-end testing.

The FIREBERD 2000 simultaneously measures bit error rate (BER), bit errors, block errors, blocks, error seconds and total seconds of test at any data rate between 100 bps and 10 Mbps. The instrument is also capable of measuring transmit frequency, receive frequency, or the frequency of a signal input through its rear panel BNC input. A seven-digit display and a variety of front panel indicators provide measurement results and the status of the system under test. Rear panel test points allow data from the system under test to be further analyzed with an oscilloscope. Additional measurement features include: a real time clock which keeps time even when the unit is unplugged from the AC power source, automatic data polarity detection, automatic synchronization, and the ability to count through error bursts.

Extensive printout capability is provided. All available results may be printed out along with the time, date, instrument ID number, and a label for each result. Data prints may be initiated manually or automatically. The front panel print controls allow automatic printing on time intervals, errors, or BER measurement cycles. Print outs are also provided on: power up, sync acquisition, sync loss, test restart, and various other important measurement events. A control print function allows all important switch positions to be printed out at the beginning of a test. This combination of printing functions allows the test conditions, sequence of events, and results to be totally documented by the printer.

A RS-232 printer interface is provided as standard equipment. This interface may be used to provide data to: the TTC model PR-1500 or PR-2000

printers, printers made by other manufacturers, or the TTC model DL 2000 magnetic data logger. When Option 07 is provided, full remote control over all front panel switches (except POWER), printer device selection and Interface Switching unit port selection are provided via this RS-232 interface. Additionally, the user gains the ability to store up to ten sets of front panel switch configurations in non-volitile memory for use at a later time.

When Option 08 is provided, this same capability is provided via an IEEE-488 Interface in addition to being provided with the RS-232 interface.

Data and clock signals interface with the FIREBERD via rugged plug-in modules which insert through the rear panel. Each Interface Module meets the appropriate standard interface specification and includes the standard connector. Over fifteen different Modules are available.

Full self-test capability is provided. This feature allows the entire FIREBERD and Interface Module in use to be tested without any additional test equipment.

1.5 EQUIPMENT SUPPLIED

The following equipment is supplied with each unit:

FIREBERD 2000

a. Power cord
b. Operating Manual
c. Protective Front Cover

FIREBERD M2000

a. Power cord
b. Operating Manual
c. Protective Front and Rear Covers

1.6 OPTIONS

The metal case option (described in section 8.8) is obtained by ordering a FIREBERD M2000. All other options may be obtained by specifying the option number.

Option Number	Descriptions
003	One Optional Clock Rate with 1 ppm Accuracy*
004	Two Optional Clock Rates with 1 ppm Accuracy*
005	Three Optional Clock Rates with 1 ppm Accuracy*
006	Four Optional Clock Rates with 1 ppm Accuracy*
007	RS-232 Remote Control**
008	RS-232 and IEEE-488 Remote Control**

1.7 ACCESSORIES

The following accessories are available. Detailed information on these accessories is provided in sections 7 and 8.

Description	Model Number
RACK MOUNTS	
Rack Mount for FIREBERD 2000 and Printer	RM-1500A
Rack Mount for FIREBERD M2000 without Printer	RM-M2000
Rack Mount for FIREBERD M2000 and Printer	RMP-M2000
Interface Switching Unit	ISU-2000

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*See Section 8 for additional information.

**These options are described in a separate manual number 10491.

Description	Model Number
PRINTER	
Thermal Printer with serial RS-232 interface and cable	PR-2000
Thermal Printer Paper (12 rolls)	10217
MISCELLANEOUS	
Extra Manual	ML-10220
Carrying Case	10170
Shipping Case	10176
INTERFACE ADAPTOR MODULES*	
RS-232 DTE	40112
RS-232 Isochronous/Synchronous DTE	40232
RS-232 Asynchronous DTE/DCE	40234
RS-232 DTE/DCE	40236
V.35/306 DTE	40138
V.35/306 DTE/DCE	40202
RS-449 (422/423) DTE	40263
RS-449 (422/423) DTE/DCE	40200
RS-449 (422/423) Bridging	40198
T1 (DS1)	40365
WECO 303	40182
LAB: TTL, 50 ohm, 100 ohm unipolar/bipolar, balanced/unbalanced	40204
Military: Mil 188-114 bipolar balanced	40298
Military: Mil 188-114 bipolar unbalanced and Mil 188C	40226
G.703 64 Kbps codirectional timing	40323

*Consult TTC for an updated list.

Description		Model Number
CABLES		
RS-232	6 ft. male to male	10213
RS-232	10 ft. male to male	10418
V.35/306	6 ft. male to male	10214
V.35/306	10 ft. male to male	10419
RS-449	6 ft. male to male	10215
RS-449	10 ft. male to male	10417
DS1	6 ft. 15 pin male to 15 pin male "D" for use with 40151 DS1 Interface Adaptor Module	10199
T1	10 ft. 310 plugs to 15 pin male "D" connector for use with 40365 T1 Interface	30375

1.8 ORDERING INFORMATION

Equipment may be ordered by contacting:

Sales
TELECOMMUNICATIONS TECHNIQUES CORPORATION
444 North Frederick Avenue
Gaithersburg, Maryland 20877
Telephone: (301) 258-5011
Telex 908736

SECTION 2
PREPARATION FOR USE

2.1 INTRODUCTION

This section provides unpacking and initial inspection instructions, warnings, and power requirements.

2.2 UNPACKING AND INITIAL INSPECTION

Inspect the shipping container for damage. If the shipping container or shipping material is damaged it should be kept until the contents of the shipment have been checked for completeness and the instrument has been checked mechanically and electrically. Procedures for checking electrical performance are given in Section 3. If the contents are incomplete, if there is mechanical damage or defect, or if the FIREBERD does not pass the performance tests, notify TTC. If the shipping container is damaged, notify the carrier as well as TTC. Keep the shipping materials for the carrier's inspection.

2.3 WARNINGS

The following precautions must be observed before and during all phases of operation of the instrument. Failure to comply with these precautions or specific warnings elsewhere in the manual may cause physical harm to the operator or to the instrument. TTC assumes no liability for the customer's failure to comply with these requirements.

GROUND THE INSTRUMENT

To minimize shock hazard, the instrument chassis must be connected to an electrical ground. The instrument is equipped with a three-conductor AC power cable. The power cable must either be plugged into an approved three-contact electrical outlet or used with a three-contact to two-contact adaptor with grounding wire (green) firmly connected to an electrical ground (safety ground) at the power outlet.

USE PROPER LINE VOLTAGE SETTING AND FUSE SIZE

Before connecting the AC power cord, verify that the line voltage selector card is positioned for the correct operating voltage. Never operate the instrument with the incorrect fuse size. See Section 2.4 for detailed information on setting the line voltage selection card and proper fuse size.

KEEP AWAY FROM LIVE CIRCUITS

Do not remove instrument covers or insert fingers or other objects through rear panel holes while power is applied to the instrument.

DO NOT SERVICE THE INSTRUMENT

Component replacement and internal adjustments must be made only by qualified maintenance personnel authorized by TTC.

TURN OFF POWER BEFORE INSERTING AND REMOVING INTERFACE MODULES.

DO NOT OPERATE IN AN AMBIENT TEMPERATURE ABOVE 50°C.

2.4 POWER REQUIREMENTS

The instrument requires a power source of 100, 120, 220, or 240 volts AC ± 10%, single phase, 48 to 66 Hz that can deliver 60 volt-amperes (maximum). The instrument is normally shipped from the factory set to operate from a 120 volt power source. To operate the instrument from a different source voltage, proceed as follows:

a. Remove the input power cord.
b. Slide the plastic door to the left.
c. Remove the fuse.
d. Pull the voltage select card straight out.
e. Change the orientation of the voltage select card and reinsert so the appropriate operating voltage is visible on the card after it has been installed.
f. Install the appropriate size fuse (See Table 2-1).
g. Slide the plastic door to the right and reinsert power cord.

Table 2-1. Fuse Size

Operating Voltage	Fuse Size	Fuse Type
100	1/2 amp 250V	3AG
120	1/2 amp 250V	3AG
220	1/4 amp 250V	3AG
240	1/4 amp 250V	3AG

SECTION 3
INSTRUMENT CHECKOUT

3.1 INTRODUCTION

This procedure is designed to offer a quick method of determining the operating status of the FIREBERD. The procedure assumes that the user is familiar with the controls and operation of the FIREBERD. The unfamiliar user may wish to review Sections 4 through 6 before attempting the instrument checkout procedure. Each section will ask the operator to perform a specific action (A) on the FIREBERD. Each action in followed by an observation (O). If the designated observation is not made, an operator serviceable diagnostic (D) is available. To increase the thoroughness of this procedure, each section may be tested in every possible combination of test parameters.

All tests are performed in LOOP TEST Mode. The FIREBERD operation in this mode is directly related to the interface module. If a failure occurs, insert another interface module and repeat the test.

Although any interface module may be used for this procedure, the interface module switches must be appropriately set and an appropriate generator clock source must be selected for the module used. If the interface module has clock invert switches, they should be placed in the NORMAL position. Other interface module switches should be set appropriately. Refer to Section 7 or the individual Interface Adaptor Module Manual if necessary. If servicing is required, it is helpful to note the section of the self test procedure where your FIREBERD failed.

3.2 PREPARATION

1. Install the interface module with the AC power off.

2. Verify that the AC line voltage card is set appropriately for the existing line voltage (See Section 2.4). Then, turn the power switch (PWR) ON.

3. The LOOP TEST switch must be in the LOOP position throughout the entire test unless otherwise specified.

4. Set the MODE switch to ERROR ANALYSIS.

3.3 SELF TEST PROCEDURE

3.3.1 Generator Clock

A (Action): Set the GENERATOR CLOCK Switch to the desired frequency. An appropriate rate for most interface modules is 19.2 Kbps. However, some interfaces such as DS1 require operation at specific rates.

If a 40151 DS1 Interface module is used, a 1.544 MHz ± 100 Hz clock signal must be provided. This may be provided by selecting the FA, FB, FC, or FD position if the appropriate oscillator option has been ordered, or by placing the GENERATOR CLOCK switch in the EXT position and sourcing the clock externally through the rear panel or interface module BNC connector.

If a 40365 T1 interface module is used, a 1.544 MHz ± 1000 Hz clock signal must be provided. This may be provided by, 1) selecting an optional oscillator in the FA, FB, FC, or FD position, 2) by placing the GENERATOR CLOCK switch in the EXT position and placing the TX TIMING switch on the interface module in the XTAL position, or 3) by sourcing an appropriate clock through the rear panel BNC connector.

O (Observation): The GENERATOR CLOCK and RCV CLOCK/TX CLOCK ACTIVITY detectors are now on.

D (Diagnostic): The GENERATOR CLOCK must be set at an available clock frequency. If the GENERATOR CLOCK switch is set in the EXT position, the clock signal used for the test must be input through the interface module unless a signal is provided at the BNC (EXT CLK IN) on the rear panel of the FIREBERD.

The FA, FB, FC, and FD positions must have the appropriate oscillator option installed.

3.3.2 Data

A: With the GENERATOR CLOCK switch set appropriately (See 3.3.1) set the PATTERN switch to 2^{20}-1, and the ERROR INSERT to OFF.

O: The RCV DATA/TX DATA activity indicator is on and the data invert (RCV DATA INV/TX DATA INV) LED is off.

D: 1. There must be generator clock activity to develop transmit clock and data.
2. FIREBERD must be in the LOOP TEST and the Interface Adaptor must be installed and set appropriately.

3.3.3 Synchronization and Error Count

A: Initial Conditions. Set:

1. GENERATOR CLOCK switch appropriately (See 3.3.1)
2. PATTERN to 2^{20}-1

3. ERROR INSERT to OFF
4. BLK LENGTH to 400
5. BER TEST LENGTH to 10^5
6. MODE to ERROR ANALYSIS
7. AUTO SYNC to ENABLE
8. Display control to UPDATE
9. LOOP TEST to LOOP
10. AUDIO INDICATOR to LOW
11. Momentarily depress RESTART

O: The FIREBERD is now synchronized with the incoming data. The SYNC LED is on and the SYNC LOST and RCV DATA INV LEDS should be off.

A: Select each DISPLAY position and verify the results.

O: 1. BER - Zero BER (0.00 E-4) - This result will be available after 10^5 bits have been received.
2. ERR - Zero
3. SEC - Counting
4. ERR SEC - Zero
5. BLKS - Counting
6. BLK ERR - Zero

A: Depress ERROR INSERT 10 Times.

O: Verify 10 errors, 10 block errors and several errored seconds.

A: Set ERROR INSERT to 10^{-3}, DISPLAY switch to BER, and depress RESTART.

O: The BER display will read 1.00E-3, and the Audio Indicator will beep twice after 10^5 bits have been received.

A: Set the BER TEST LENGTH switch to AUTO and depress RESTART.

O: The BER display will be 1.00E-3, and the Audio Indicator will beep twice after 10^5 bits have been received.

D: 1. At the other operating frequencies or test lengths the results may take longer to appear. The BER Mode update is dependent on the clock rate and the BER test length.

$$\text{BER update time in seconds} = \frac{\text{test length (bits)}}{\text{Clock frequency (bits/secs)}}$$

2. There must be a receive clock and data signal for synchronization to occur.
3. Be sure the generator clock is active and that you are not exceeding the maximum data rate inherent to your particular interface module:

V.35 - 10 MHz	Lab - 10 MHz
RS-232 - 20 KHz	WECO 303 - 500 KHz
*449 - 423 - 20 KHz or 112 KHz	DS1 - 1.544 MHz $\pm$ 100 Hz
449 - 422 - 10 MHz	

* 112 KHz maximum RS-423 mode operation for models 40180 and 40263 RS-449 DTE Interface Modules and model 40200-01 RS-449 DTE/DCE Interface Module, 20 KHz for model 40200-02 RS-449 DTE/DCE Interface Module.

3.3.4 Frequency

A: Set the MODE switch to TX FREQ and the LOOP TEST switch to LOOP.

O: Verify that the display shows the correct frequency for each position of the GENERATOR CLOCK switch.

A: Set the MODE switch to RCV FREQ.

O: Verify that the display shows the correct frequency for each position of the GENERATOR CLOCK switch.

D: 1. The DISPLAY switch must be in one of the 5 left-most positons to display the frequency results.
2. The RCV CLOCK/TX CLOCK and Generator Clock activity indicators must be on.
3. Check the Interface Adaptor for proper installation.
4. When using the FIREBERD as a DTE, the transmit clock signal is selected by the GENERATOR CLOCK switch and the receive clock signal is that signal at the input to the error analysis circuitry. For DCE operation, the receive clock signal is selected by the GENERATOR CLOCK switch and the transmit clock source is the signal input to the FIREBERD error analysis circuitry.

3.3.5 Time Set

A: Set the DISPLAY switch to the BER position.

A: Depress and hold the PRINT CONTROL toggle switch in the RESULTS position.

O: Within 3 seconds the FIREBERD will enter Time Set Mode and the display will flash the Hours position.

A: With the CLK SET switch, increment the Hours position 24 hours and release the RESULTS switch.

O: Verify the time or date has not changed and that the seconds did not reset to Zero.

D: 1. Time/Date and Time Set Modes are dependent only on the instrument power supply. Be sure the PWR LED is on.

2. Time and Date are only updated if any one of the parameters have been changed before releasing the RESULTS switch.

3. The seconds can only be set to zero. If they are not set, the count continues throughout the Time Set procedure.

Note: The 5 left-most DISPLAY switch positions set the units of the Real Time Clock.

3.3.6 Printer

A: Connect the cable provided between the PR2000 printer and the RS-232 PRINTER connector on the rear panel of the FIREBERD.

A: Initial conditions, Set the following controls as indicated:

1. GENERATOR CLOCK to appropriate rate
2. ERROR INSERT to 10^{-3}
3. BLK LENGTH to 400
4. BER TEST LENGTH to 10^{5}
5. MODE to ERROR ANALYSIS
6. PRINT CONTROL (EVENT) to BER CYCLE
7. Depress RESTART switch
8. RS-232 DATA FORMAT - set all switches up, cycle the POWER switch OFF, and then ON if the RS-232 DATA FORMAT switch is changed.

O: A data printout occurs including all error analysis test results after 10^5 bits have been received.

A: Set the EVENT and ERROR INSERT switches to OFF.

O: Verify that data printouts stop after the present printout.

A: Set the EVENT switch to ERR, and insert a single error, then depress the RESULTS switch.

O: Verify the printing of two sets of Data Results.

A: Place the PRINT CONTROL switch to the controls position.

O: Verify the printing of all FIREBERD switch positions except CLK SET, PWR, RESULT HOLD/UPDATE/RESTART, CONTROLS/AUTO/RESULTS, DISPLAY, and the AUDIO INDICATOR switch positions. Note that the FIREBERD does not print Interface switch positions except for the RS-449 DTE/DCE, V.35/306 DTE/DCE, RS-449 BRIDGING INTERFACE modules.

D:
1. All printer functions are disabled in the PRINT CONTROL OFF position except for manually activated prints.
2. Verify the printer paper is not empty and that the interconnecting cable is secure.
3. If the PR-2000 printer cable was attached to the printer after the printer was powered up, the printer power must be cycled or the printer self test must be activated before printing will occur.

SECTION 4
INSTRUMENT DESCRIPTION

4.1 INTRODUCTION

This section provides a detailed description of each control, indicator, connector, and test point on the FIREBERD. This is followed by a functional description for each of the major elements which make up the instrument.

4.2 CONTROL, INDICATORS, CONNECTORS, and TEST POINTS

Figures 4-1 and 4-2 are photographs of the front and rear panels, respectively. The numbers on these figures correspond to the numbered descriptions which follow.

It is important to note that the movement of some switches on the FIREBERD will restart a test and others may be changed without affecting the ongoing test, i.e.

Switches that cause a test restart:

GENERATOR CLOCK
PATTERN
MODE
LOOP TEST
RESTART
BLK LENGTH
BER TEST LENGTH
PWR
Interface Module switches on some interfaces

Switches which will not cause a test restart:

ERROR INSERT
DISPLAY
AUTO SYNC*
RESULT HOLD/UPDATE/RESTART (except the RESTART position)
RS(RTS)/RR(RLSD)
TR(DTR)/DM(DSR)
AUDIO INDICATOR
PRINT CONTROL

4.2.1 Selector Switches (See Figure 4-1)

1. GENERATOR CLOCK TX (RCV):
   1.2/2.4/4.8/9.6/19.2/56/64/FA/FB/FC/FD/EXT

   Selects the Generator Clock from: one of seven standard internal frequencies (1.2, 2.4, 4.8, 9.6, 19.2, 56, and 64 kHz), one of the optional user selected internal frequencies (FA, FB, FC, or FD), the external input (EXT) on the plug-in Interface Module, or the rear panel BNC (EXT CLK IN).

The EXT position of this switch will select the signal from the BNC (EXT CLK IN) as the input when a signal with a voltage of .6 volts to 25 vpp is present at the BNC connector, otherwise it will select the external clock input from the Interface Module.

---

*If an error rate of 10^{-1} or greater occurred in the auto sync disable mode, switching to auto sync enable mode will cause a test restart.

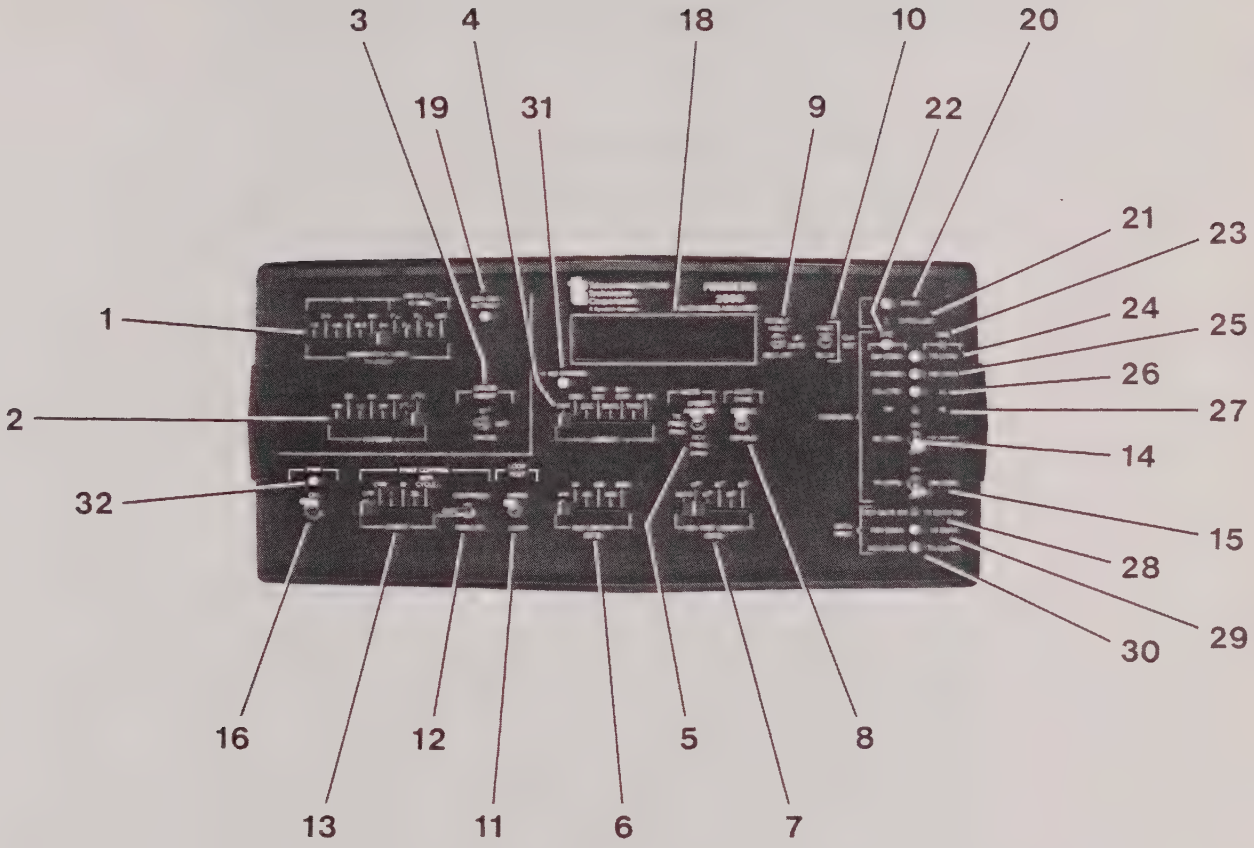

Figure 4-1
FIREBERD 2000 FRONT PANEL

2. PATTERN: MK/SP/1:3/63/511/2047/2^{15}-1/2^{20}-1

Selects the generator and receiver test patterns in Error Analysis Mode from: constant mark (MK), constant space (SP), 1:3, or one of five pseudorandom patterns (63, 511, 2047, 2^{15}-1, 2^{20}-1).

3. ERROR INSERT: 10^{-3}/OFF/SINGLE

One error is inserted in the generated data pattern each time this switch is depressed (SINGLE). In the center position (OFF), no errors are inserted. In the upper position, (10^{-3}) a continuous error rate of one error per 1000 bits is inserted into the generated data stream.

4. DISPLAY: BER/ERR/SEC/ERR SEC/BLKS/BLK ERR/TIME/DATE

Selects the result to be displayed. In Error Analysis Mode, the results are: Bit Error Rate (BER), Errors (ERR), Seconds (SEC), Errored Seconds (ERR SEC), Blocks (BLKS), Block Errors (BLK ERR), Time and Date. In either Frequency Mode, the appropriate freqency result is displayed in all positions except TIME or DATE.

5. MODE: ERROR ANALYSIS/TX FREQ/RCV FREQ

This switch selects one of the three operating modes for the test set. The source of the clock and data for measurements is dependent on DTE or DCE mode of operation.

In Error Analysis Mode, error analysis functions are performed on the receive clock and data signals for DTE operation or the transmit clock and data signals for DCE operation.

Transmit Frequency (TX FREQ) Mode measures and displays the clock signal from one of two sources. In the DTE operation, the source for this measurement is the clock signal selected by the GENERATOR CLOCK switch. In DCE operation, the source for this measurement is the clock signal received by the error analysis circuitry.

In Receive Frequency (RCV FREQ) Mode the clock signal for this measurement is taken from one of two sources. In DTE operation, the source is the clock signal being received by the error analysis circuitry. For DCE operation, the source is the signal selected by the GENERATOR CLOCK switch.

6. BLK LENGTH (bits): 400/1K/4K/10K/40K/100K

Selects the Block Length in bits used to develop the Block and Block Error results for an error analysis test.

7. BER TEST LENGTH (bits):
AUTO/10^5/10^6/10^7/10^8/10^9

The right-most 5 positions of this switch indicate the number of bits used to compute the BER result. For example, in the 10^7 position, errors are accumulated over a period of 10^7 bits, the number of errors is then divided by 10^7 to get the BER result.

The AUTO position performs a BER test which counts errors for a 10^5 bit interval. After 10^5 bits a BER result will be available to be displayed or printed. The BER test will be restarted at this point if 100 or more errors have been accumulated. If less than 100 errors have been counted, the BER test will continue

until 10^6 bits have been received at which time the new result will be available for display or printout. If less than 100 errors are present the measurement will continue until 10^7 bits have been received. In this manner, the BER test will continue until a result with at least 100 errors is available or until a 10^{11} bit test length is completed. In either case, the result will be output and the test restarted. The last complete result obtained (a result with more than 100 errors or a result for a 10^{11} bit interval) will be used for display and printout until the next result with more than 100 errors or 10^{11} bits is obtained.

8. AUTO SYNC: ENABLE/DISABLE

When a synchronization is initiated in Error Analysis Mode, the automatic synchronization circuitry will attempt to lock on to the incoming data. Once synchronization has been obtained, the position of the AUTO SYNC switch determines how the test set will respond to very high error rates.

In the ENABLE position, the receiver will automatically resynchronize and restart the test if more than 100 errors occur in a 1000 bit interval (10^{-1} error rate).

In the DISABLE position, the receiver is inhibited from resynchronizing at any rate. This allows the unit to perform measurements on channels with high error rates whch would normally cause the unit to resynchronize and restart the test.

The ENABLE position should be used unless error burst or error rates greater than 10^{-1} are anticipated. The

AUTO SYNC switch may be changed from the ENABLE to the DISABLE position during a test without causing a test restart. When this switch is changed from DISABLE to ENABLE, the test will not restart unless the error rate exceeds 10^{-1}.

9. RESULT HOLD/UPDATE/RESTART

Depressing this switch into the RESTART position, in the Auto Sync Enable Mode, will clear all of the FIREBERD result accumulators and restart the test. This will not cause a resynchronization to the incoming data. Depressing this switch in the Auto Sync Disable Mode will clear all of the result accumulators, restart the test, and force a resynchronization to the incoming data.

The UPDATE position allows the Display to change as the ongoing tests dictate. This is the normal operating position for the FIREBERD test set.

The RESULT HOLD position will freeze the result currently being displayed as well as all other results selectable with the DISPLAY switch.

10. CLK SET: FAST/SLOW

Increments the time or date units when setting the Real Time Clock

To enter Time Set Mode the PRINT CONTROL toggle switch is held in the RESULTS position. After 3 seconds, Time Set Mode is activated. Time or date parameters to be set are selected by the 5 left-most DISPLAY switch positions.

Once in Time Set Mode, the time or date parameters to be set will be flashing on the Display. The new time and date presently displayed will be set when the RESULTS switch is released. When setting the seconds, depressing the CLK SET switch to either the FAST or SLOW positions will set the seconds to zero instead of incrementing the count.

11. LOOP TEST: NORM/LOOP

The Normal (NORM) position is selected for normal Data Error Analyzer operation. The LOOP position activates a relay or data selector on the Interface Adapter which loops the transmit clock and data outputs back to the receive clock and data inputs. The relay or data selector also isolates the interface connector so that the interface cable need not be removed for the loop test.

12. PRINT CONTROL: CONTROLS/AUTO/RESULTS

This toggle switch allows 3 modes of printer operation. The RESULTS position causes a printout of all available results (including time, date, and ID number) for either Error Analysis or Frequency Mode.

The AUTO position allows data outputs to be controlled by the EVENT switch.

The CONTROLS position provides a printed record of all test parameters set by the front panel switches. This position will also cause a printout of the Interface Module switch positions for some types of interfaces.

13. PRINT CONTROL/EVENT: OFF/ERR/1/10/30/BER CYCLE

The OFF position disables the data output to the printer. Only manually activated print commands will cause a printout. All printer data is buffered before reaching the printer; entering the OFF position clears this buffer.

In Error Analysis Mode, the Error (ERR) position causes a printout to be initiated on the occurrence of an errored second and every 60 minutes. The 1, 10, and 30 positions initiate printouts every 1, 10, and 30 minutes, respectively. The BER CYCLE position initiates a print at the end of each BER measurement cycle as set by the BER TEST LENGTH switch.

In Frequency Mode data prints are initiated every 1, 10, or 30 minute interval dependent on the position of the EVENT switch.

14. RS(RTS)/RR(RLSD): ON/OFF

Controls the state of the Request to Send signaling leads output when the FIREBERD is used as a DTE with V.35/306, RS-232, RS-449 or WECO 303 type interface modules. For DCE operation this switch controls the Receiver Ready (RR) signaling lead for the RS-449 DTE/DCE interface module and Receive Line Signal Detect (RLSD) for V.35/306 DTE/DCE or RS-232 synchronous or asynchronous DTE/DCE interface modules.

15. TR(DTR)/DM(DSR): ON/OFF

In DTE operation, this switch controls the state of the

Terminal Ready signaling lead output from RS-449 type Interface Modules; or the Data Terminal Ready output for V.35/306 or RS-232 Interface Modules.

In DCE operation, this switch controls the state of the Data Mode output for RS-449 type Interface Modules; or the Data Set Ready output for V.35/306 or RS-232 Interface Modules.

Note that older versions of RS-232 DTE, WECO 303, V.35/306 DTE and RS-449 Interface Modules hold the Terminal Ready or Data Terminal Ready output continuously ON, independent of the position of this switch. Refer to Section 7 for details on how to determine if one of these Interface Modules allows TR or DTR control.

16. PWR: ON

Applies power to, or removes power from the instrument.

4.2.2 Indicators - (Figure 4-1)

18. SEVEN DIGIT DISPLAY

Displays Error Analysis and Frequency test results. All decimal points illuminate when the result being displayed has overflowed.

19. GEN CLK ACTIVITY

Indicates that a clock is present at the pattern generator (transmit clock for DTE operation or receive clock for DCE operation).

20. SYNC

Indicates that the receiver is synchronized to the incoming data. Must be illuminated for an error analysis test to proceed.

Once synchronization is obtained, loss of synchronization will not be detected in AUTO SYNC DISABLE MODE. This indicator will be off in Frequency Mode.

21. SYNC LOST

In Auto Sync Enable Mode, this indicator will illuminate when synchronization has been lost at least once since the test started. Once illuminated, this LED will only be reset by starting a new test via the TEST RESTART switch or by changing one of the test parameters which causes a Test Restart.

In Auto Sync Disable Mode, this indicator will illuminate if the error rate has exceeded 10^{-1} over the last 10^{5} bit interval. The state of this LED is updated every 10^{5} bits in this mode. This indicator will be off in Frequency Mode.

22. DTE

Illuminates when the FIREBERD is acting as Data Terminal Equipment (DTE).

23. DCE

Illuminates when the FIREBERD is acting as Data Communication Equipment (DCE).

24. DM(DSR)/TR(DTR)

Illuminates when the Data Set Ready Signaling lead is in the ON condition during DTE operation for the RS-232, WECO 303, and V.35/306 interfaces; or when the Data Mode signaling lead is in the ON condition for RS-449 interfaces. In DCE operation, the LED illuminates when Data Terminal Ready or Terminal Ready is in the ON condition for the respective interface. Not applicable for DS1 or Lab Interfaces.

25. RR(RLSD)/RS(RTS)

When the FIREBERD is acting as a DTE, this indicator illuminates when the Receive Line Signal Detector is in the ON condition for the RS-232 or V.35/306 type interfaces, or when the Receiver Ready is ON for the RS-449 type interfaces.

When the FIREBERD is acting as a DCE, this indicator will illuminate when the Request to Send signaling input is in the ON condition for RS-232 DTE/DCE, RS-449 DTE/DCE and V.35 DTE/DCE interfaces.

26. CS(CTS)/LL

Illuminates when the Clear to Send Signaling lead is in the ON condition during DTE operation for interfaces which support CTS. When the FIREBERD is acting as a DCE this indicator illuminates when the Local Loopback input is in the ON condition for RS-449 DCE/DTE or the RS-449 Bridging interface.

27. TM/RL

This indicator illuminates in DTE operation when the Test Mode signaling lead input is at the ON condition for the RS-449 DTE/DCE and Bridging Interfaces. During DCE operation, it illuminates when the Remote Loopback is in the ON condition for RS-449 DTE/DCE and Bridging interfaces.

28. RCV DATA INV/TX DATA INV

Illuminates in DTE operation when the received data is inverted with respect to the generator data, or in DCE operation when the data being received by the FIREBERD error analysis circuitry (TX DATA) is inverted with respect to the generator data. This indicator is not applicable when there is no sync or in the Frequency Mode.

29. RCV DATA/TX DATA

Indicates there is receive data activity in DTE operation or transmit data activity in DCE operation.

30. RCV CLOCK/TX CLOCK

Indicates during DTE operation that there is receive clock (RCV CLOCK) activity at the input to the error analysis circuitry. For DCE operation, this indicator illuminates when there is transmit clock (TX CLOCK) activity at the input to the error analysis circuitry.

31. 100 ERRORS

Illuminates when less than 100 errors have been accumulated for the BER result presently available. This indicator is updated each time a new BER result is available. Note that this LED may be illuminated even when the error count displayed by the ERR position of the DISPLAY switch is greater than 100 since BER is measured cyclically and the displayed error count is a total error count since the test was started. This indicator is not used in Frequency Mode.

32. PWR

Illuminates when FIREBERD has power applied.

4.2.3 Connectors - (Figure 4-2)

33. EXT CLK IN

Used to input signals ranging from .6 volts to 25 volts peak to peak for use as the generator clock when the GENERATOR CLOCK switch is in the EXT position. If no signal is present at the EXT CLK IN (BNC) input, the signal selected by the EXT position of the GENERATOR CLOCK TX(RCV) switch is the external clock input from the interface adaptor. Place the BNC cap over this connector when not in use.

34. RS-232 PRINTER

Used to interface with a RS-232 printer or the DL-2000 Data Logger. Also used for remote control inputs when option 007 or 008 is provided.

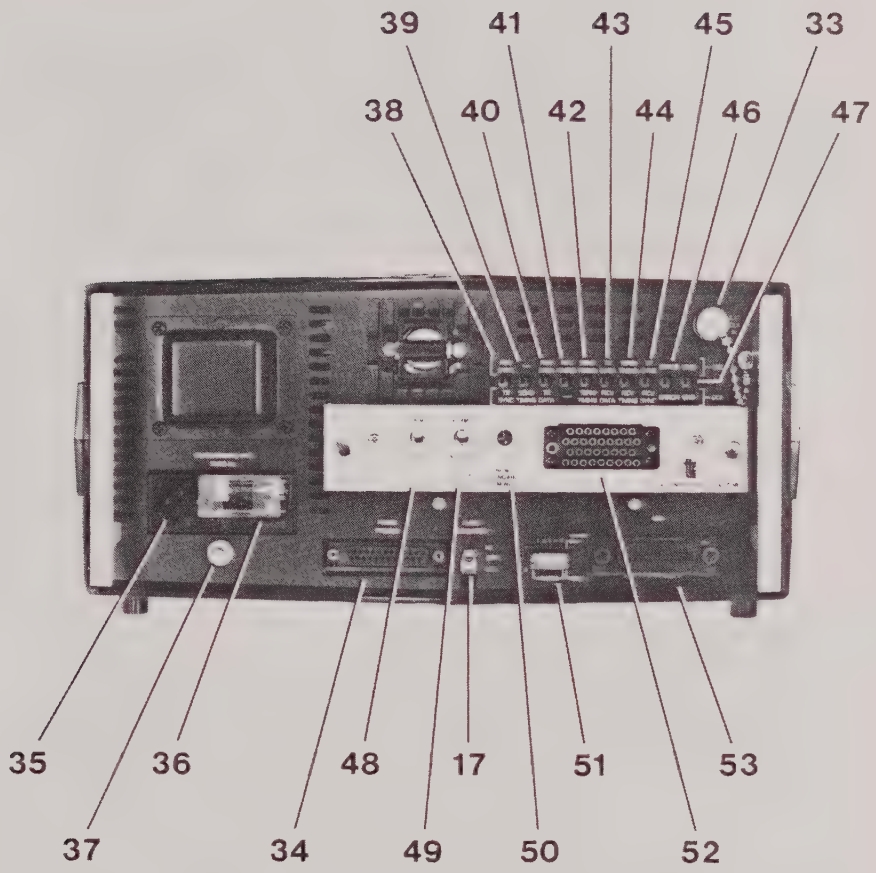

Figure 4-2
FIREBERD 2000 REAR PANEL

35. AC INPUT

Power input from AC line.

36. VOLTAGE SELECT 100/120/220/240

Used to select AC operating voltage. Voltage setting may be changed by: removing power cord, sliding plastic door to the left, removing fuse, and finally removing selector card. Once removed, the card may be flipped over and reinserted to select a different operating voltage range. The operating voltage selected is visible through the plastic door once the card is installed.

37. GROUND STUD

Connected to chassis and circuit ground.

53. IEEE-488 INTERFACE CONNECTOR

Connector for the IEEE-488 Option. (Provided only with option 008)

4.2.4 Test Points - (Figure 4-2)

All test points except ground (GND) are driven by standard TTL gates with series 220 ohm resistors.

In the descriptions which follow, test points which have different names for DTE and DCE operation have a "/" separating the two names. The names on the left and right are applicable for DTE and DCE operation respectively. A "-" indicates that the test point is not applicable for the particular operating mode.

38. RCV SYNC/TX SYNC

This test point provides one pulse for each repetition of the incoming pseudorandom pattern.

39. -/SEND TIMING

For DCE operation this test point develops a signal equivalent to that being transmitted at the Send Timing (ST) or TX Clock DCE source interface output lead. This is not applicable in DTE operation.

40. RCV DATA/TX DATA

This test point develops a signal equivalent to the signal at the incoming data input to the error analysis circuitry of the FIREBERD.

41. RCV TIMING/-

For DTE operation the Receive Timing test point provides a TTL signal equivalent to the received clock at the input to the interface adaptor. This test point is not applicable for DCE mode.

42. SEND TIMING/TERM TIMING

Outputs a TTL signal equivalent to the clock signal at the Interface connector. Note that SEND TIMING is equivalent to TX Clock DCE source and TERM TIMING is equivalent to TX Clock DTE Source.

43. TX DATA/RCV DATA

This test point provides a TTL equivalent to the data signal output from the Interface Adaptor.

44. TERM TIMING/RCV TIMING

This test point provides a TTL equivalent to the generator clock at the output of the Interface Adaptor.

45. TX SYNC/RCV SYNC

This test point provides one pulse for each repetition of the pseudorandom pattern generated by the FIREBERD.

46. ERROR

For DTE or DCE operation this test point stays high one clock period for each error detected by the FIREBERD error analysis circuitry.

47. GND

Provides a circuit and chassis ground.

4.2.5 Interface Module Components (V.35/306 DTE Interface Shown in Figure 4-2)

48. TX CLK: NORMAL/INVERT

In the NORMAL position, the clock-data phase relationship at the Interface Adapter will be as specified for normal V.35/306 operation. The INVERT

position causes the clock-data phase relationship to be inverted to that specified for normal operation.

49. RCV CLK: NORMAL/INVERT

In the NORMAL position, the FIREBERD error analysis circuitry expects to see the clock-data phase relationship as specified for normal V.35/306 operation. In the INVERT position, the FIREBERD expects to see the phase relationship inverted to that specified for normal operation.

50. NON-STANDARD TIMING

Illuminates when either the TX CLK or RCV CLK switch is placed in the INVERT position.

4.2.6 Rear Panel Switches (Figure 4-2)

17. AUDIO INDICATOR: HI/OFF/LO

Sets the internal Audio Indicator to high volume, off, or low volume. In Error Analysis Mode, the indicator will beep twice at the end of each BER measurement cycle and three times on the occurrence of a sync loss. If the DISPLAY switch is in the ERR or ERR SEC position, it will also beep on the occurrence of an errored second. The Audio Indicator does not function in Frequency Mode.

51. IEEE-488 INTERFACE CONTROL SWITCH

This switch controls the operation of the IEEE-488 Interface when option 008 is provided. The right-most

switch selects Talk Only Mode in the up position or Addressable Talker/Listener Mode in the down position. The left most five switches select the address for Addressable Mode. Each switch sets the corresponding address bit to a one or zero for the up or down position, respectively.

54. RS-232 DATA FORMAT SWITCH
(Not shown in Photograph)

An 8 position DIP switch is located under the rear panel power connector. This switch allows interface parameters such as baud rate, stop bits, parity and line termination characters to be selected. Table 4-1 shows the parameter selections for each position of the DIP switch. All switches should be in the UP position for operation with the TTC PR-2000 thermal printer.

NOTE: This DIP switch is read by FIREBERD on power-up only so the POWER switch should be cycled if changes are made.

4.3 INTERNAL DESCRIPTION

4.3.1 General

The FIREBERD can be functionally divided into six sections: Transmitter, Interface Module, Receiver, Processor, Control Panel, and Power Supply. Figure 4-3 is a block diagram for the FIREBERD. Refer to this diagram for the following description.

The Transmitter generates the test pattern to be used for the error analysis measurements. The transmit side of the Interface Module provides a

TABLE 4-1

RS-232 Data Format Switch

SWITCH NUMBER	FUNCTION	SELECTIONS
1	Baud Rate	up for 600 and 2400 down for 300 and 1200
2	Baud Rate	up for 1200 and 2400 down for 300 and 600
3	Stop Bits	up for 2 stop bits down for 1 stop bit
4	Mode	always up
5	Parity	up for even parity down for odd parity
6	Line Termination	up for carriage return down for carriage return and linefeed

signal conversion from the TTL characteristics provided by the Transmitter to the characteristics appropriate for the interface standard in use. The output of the Interface Module drives the system under test. The test pattern passes through the system under test and is received by another FIREBERD or is looped back to the same FIREBERD which originated it. In either case, the receive portion of the Interface Module converts the received pattern into a TTL signal and passes it on to the Receiver.

The Receiver synchronizes a pattern generator identical to the one in the Transmitter with the incoming data stream. The output of this pattern generator is compared with the incoming data and an error pulse is generated for each discrepancy between the transmitted and received data. Several counters accumulate bit count, error count, block count, and block error count.

In Frequency Mode, the Receiver selects either the transmit or receive clock and provides a pulse count to the Processor.

The Processor serves as a controller and computer for the instrument. It inputs control setting information from the Control Panel, timebase and status information from the Transmitter, switch setting and signaling from the Interface Module, and result counts from the Receiver. Results and system status information are computed and output to the Control Panel display and LED indicators, printer interfaces, and tone generator.

4.3.2 Transmitter

The transmitter generates the digital test pattern using a 20 stage shift register with adjustable feedback taps to an exclusive-OR gate feeding the shift register input. The configuration of this shift register is set by a front panel switch to provide 63, 511, 2047, $2^{15}-1$, or $2^{20}-1$ pseudorandom patterns. Alternatively, a mark, space, or 1:3 (one mark followed by three spaces) pattern may be selected.

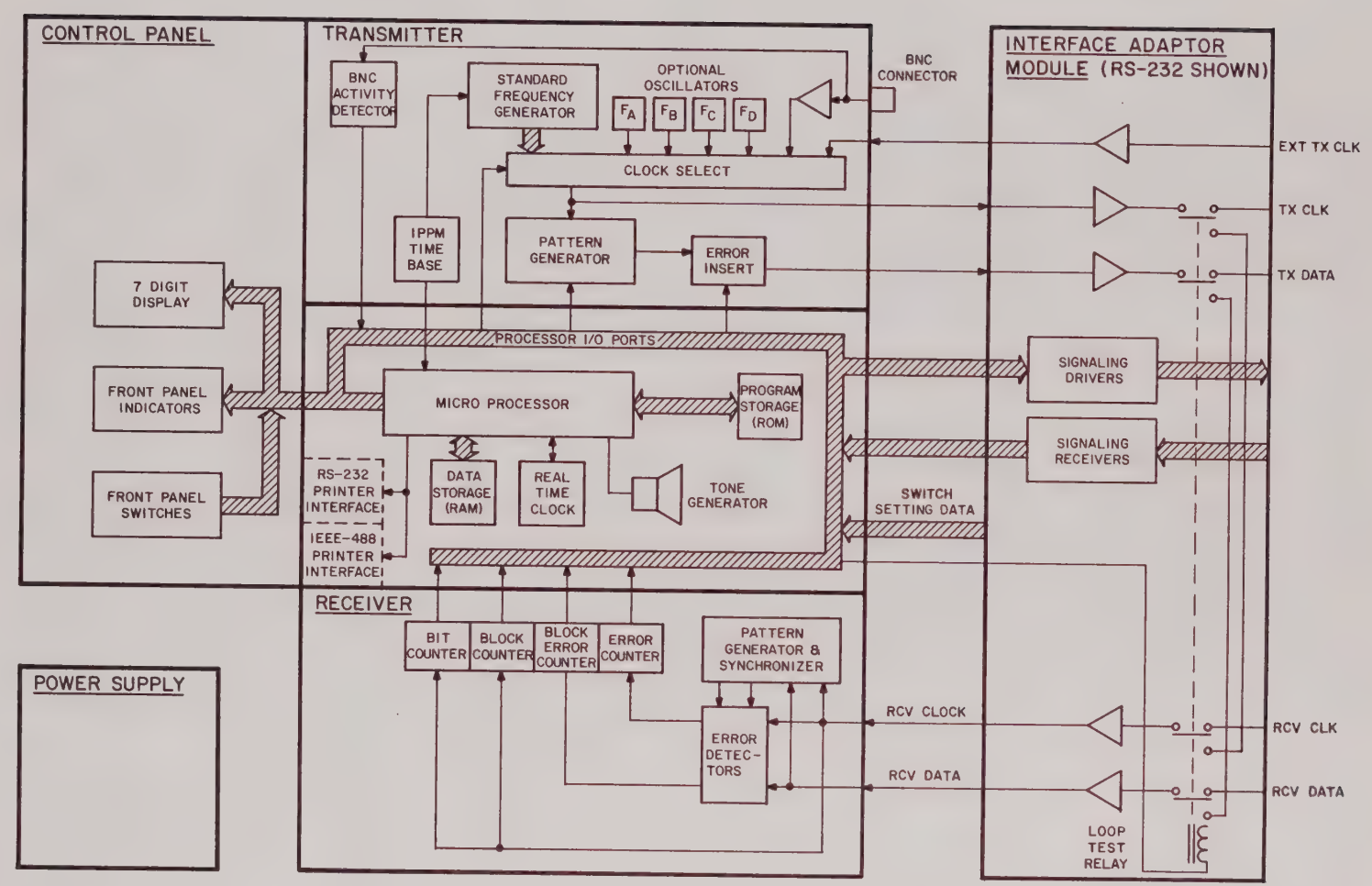

FIGURE 4-3
FIREBERD 2000 BLOCK DIAGRAM

A timebase with a 1 ppm accuracy provides timing to the Processor and standard frequency generator. The Processor uses information from the GENERATOR CLOCK switch and BNC activity detector to generate signals which tell the clock select circuitry to select: one of the standard internal rates, one of the four optional oscillators, the external clock from the BNC receiver, or the external clock from the Interface Module. The selected clock is used to drive the pattern generator and is sent back to the Interface Module.

Error insert circuitry is provided between the pattern generator and the Interface Module's data input. Each time the ERROR INSERT switch is depressed to the SINGLE position, one bit in the transmitted data stream is inverted. When the switch is placed in the 10^{-3} position, one bit in every thousand bits is inverted.

A transmit pattern sync output on the rear panel provides one pulse for every repetition of the selected pseudorandom pattern. This output may be used to synchronize an oscilloscope to the pseudorandom pattern while tracing the test pattern through a system or looking for the presence of errors.

The transmit data and clock are passed from the error insert and clock select circuitry to the Interface Module which provides the electrical characteristics appropriate to drive the system under test.

4.3.3 Interface Module

The Interface Module shown in Figure 4-3 and described here is a RS-232 synchronous DTE type. Other Interface Modules are described in Sections 5.3, 5.4, and Section 7.

The transmit section of the Interface Module contains a line receiver which receives an external clock (if one is in use) and directs it to the Transmitter's clock select circuitry. It also provides line drivers for the

transmit clock, transmit data, request to send, and data terminal ready outputs.

The receive section of the Interface Module provides line receivers for the receive clock, receive data, clear to send, data set ready and receive line signal detect. The received clock and data signals are passed to the receiver for error analysis and the signaling status is sent to the Processor for front panel display and printout.

The Interface Module also provides clock invert switches (not shown) for both the transmit and receive clocks. When the transmit clock switch is in the NORM position, the phasing between the transmit clock and data is as specified by the interface specification. In the INVERT position, the phasing is opposite to that specified by the interface specification. The receive clock invert switch works in the same manner for the phasing between the receive clock and data. A red LED illuminates to warn the operator of non-standard timing when either of the switches is taken out of the NORM position.

A relay is provided for loop testing. When the LOOP TEST switch on the FIREBERD front panel is activated, the relay on the Interface Module loops the transmit clock and data outputs back to the receive clock and data inputs. The relay also disconnects these same lines from the interface connector so that the interface cable need not be disconnected for the test. This loop test feature allows the operator to insert errors with the ERROR INSERT switch and verify the proper operation of both the FIREBERD and Interface Module.

4.3.4 Receiver

The Interface Module provides receive data and clock signals at TTL levels to drive the receiver.

On test initialization in Error Analysis Mode, the pattern generator in the receiver (identical to the one in the Transmitter) is automatically synchronized to the incoming data. Once synchronization has occurred, the error detector compares the incoming data with the internally generated pattern and counts discrepancies as errors. If the incoming data is inverted, the unit will automatically correct the inversion, attempt synchronization, and illuminate a front panel indicator. This allows the measurement to be performed and warns the operator of the data inversion in the system under test.

If a loss of synchronization is detected between the incoming data and pattern generator after synchronization has been obtained, the unit will automatically resynchronize the receive pattern generator, turn on the SYNC LOST LED and restart the measurement. The SYNC LED will always be illuminated when the FIREBERD has obtained synchronization. It must be illuminated for the test to proceed.

A group of counters in the Receiver accumulate error count, bit count, block error count, and block count. The results in these counters are periodically added into software accumulators in the Processor.

In Frequency Mode, the Receiver uses its error counter to accumulate the total number of clock cycles of either the transmit or receive clock. This data is entered into the Processor and the counter is reset every 10 ms.

4.3.5 Control Panel

The Control Panel provides all front panel switches, indicators, and displays. Switch outputs are encoded and debounced (if necessary) and then passed directly to the Processor input ports. The Processor drives the seven-digit display and LED indicators through output ports.

4.3.6 Processor

The Processor serves as the controller and computer for the test set. It scans the controls and inputs signaling and status information from various circuits in the instrument. This information is used to compute the status outputs which are provided to the LED indicators, tone generator, and printer interfaces. It is also used to derive the control signals which control various circuits such as the pattern generator and the clock select circuit.

The Processor inputs data from the Receiver, computes results, and provides the results along with time data from the real time clock to the seven-digit display, tone generator, and printer interfaces.

A RS-232 printer interface is provided on each unit and an optional IEEE-488 addressable talker only interface is available. The Processor determines when data is to be printed according to front panel controls and test events. When data is to be output, the data is fed into a 512 byte FIFO (first in, first out memory). The output of the FIFO drives either the RS-232 or IEEE-488 interfaces. The FIFO allows the Processor to store data to be printed, as it occurs, until the printer has time to print it.

4.3.7 Power Supply

The power supply provides filtered and well regulated DC voltages to all circuitry with the FIREBERD. The instrument case incorporates an internal metalized coating and line filter to minimize EMI/RFI susceptibility.

SECTION 5
OPERATION

5.1 INTRODUCTION

This section provides a detailed description of measurement capability and possible measurement configurations. This is followed by a discussion of factors to consider (such as timing modes and parameter selection) when using the instrument. The last section provides a step-by-step operating procedure which may be used as an operating guide.

5.2 MEASUREMENT CAPABILITY

5.2.1 Error Analysis Mode

The FIREBERD 2000 measures errors, error seconds, seconds, blocks, block errors, BER (Bit Error Rate) and average BER. These are defined as follows:

Error - an error is counted when a bit is received which has value different than the value that was transmitted.

Error second - an error second is counted each time a second ends in which one or more errors occurred.

Seconds - time since the test started

Block - a block is counted each time the number of bits received since the end of the last block equals the block length, as set by the BLOCK LENGTH switch.

Block error - a block error is counted when the block count is incremented if any of the bits in the block were in error.

BER - Bit Error Rate is defined as the total number of errors counted, divided by the total number of bits used to perform the measurement.

Average BER - in the five fixed test length positions of the BER TEST LENGTH switch, the average BER over the last ten BER measurement intervals is computed. This result is available for printout only and can not be displayed.

All measurements start shortly after synchronization is acquired or when the TEST RESTART switch is depressed. All measurements except BER continue until: synchronization is lost, the test is restarted by depressing the TEST RESTART switch, or when the position of one of the switches which cause a forced resynchronization is changed. The BER measurement is performed over a number of bits determined by the BER TEST LENGTH switch (See Section 4.2.1, #7 for description). Each time a full BER measurement interval has been completed the BER measurement will be restarted.

During the first BER measurement interval after the test starts, intermediate BER results will be computed each time the total number of bits received is equal to a power of ten which is greater than 10^4 but less than the full measurement interval. These intermediate results are available for display and printout in the AUTO position of the BER TEST LENGTH switch. The results will be available for printout only in other positions of the BER TEST LENGTH switch.

When at least one full measurement interval has been completed, the result from that measurement interval will be used for display and printout until the next full measurement interval is complete, at which time the old BER result will be replaced with the new value.

5.2.2 Frequency Count Mode

The frequency counter is capable of measuring frequencies between 200 Hz and 13 MHz. Each measurement is performed over a one second interval and produces a result which is accurate to ± 1 ppm ± 1 Hz.

The MODE switch allows measurement of the transmit or receive frequency. When the FIREBERD is acting as a DTE (Data Terminal Equipment), the transmit clock will be the signal used to generate the transmit data pattern. This clock is selected by the GENERATOR CLOCK switch, thus the frequency of any of the following may be measured: optional oscillators, an external transmit clock supplied by the DCE (Data Communications Equipment), or an external clock supplied through the rear panel BNC connector. When the FIREBERD is acting as a DTE, the receive clock will be the clock input to the FIREBERD receiver for error analysis measurements. This clock will be provided by the DCE for synchronous applications or recovered by the Interface Module for isochronous operation. The frequency counter should not be used to measure transmit or receive frequency supplied by an Asynchronous Interface Module since this clock will be gated on and off.

When the FIREBERD is acting as DCE, the transmit clock will be the clock input to the FIREBERD receiver for error analysis. The Interface Module switches determine if this clock is to be supplied by the DTE or is generated by the FIREBERD and looped back internally. When the FIREBERD acts as a DCE, the receive clock is the clock selected by the GENERATOR CLOCK switch and may come from: one of the optional oscillators, an external clock supplied by the DTE, or an external clock supplied through the BNC connector. Section 5.4 provides additional information on timing flow for various operating modes. See Section 5.4.7 for termination suggestions and signal restrictions at the BNC input.

5.3 MEASUREMENT CONFIGURATIONS

Figure 5-1 shows four possible measurement modes for system testing with the FIREBERD 2000. Figure 5-1a shows local system testing. One FIREBERD test set is used to test a modem or communication system which has its transmit output looped back to its receive input. Figure 5-1b shows a simplex end-to-end test. This configuration requires two test sets located at opposite ends of the link. One test set generates data and sends it into the communication system. The other test set receives the data, performs the error analysis and displays the results. Figure 5-1c shows a full duplex end-to-end test. This test is similar to the simplex test except that testing is simultaneously performed in both directions. Whenever two test sets are used for measurements, each test set displays the results measured by its receiver. Figure 5-1d shows a full duplex loop around test. The data is looped around at the digital side on the remote end of the communication system.*

Figure 5-2 shows various points that FIREBERD test sets could be connected to a communication system for error analysis. Various combinations of the above measurement modes can be used to test the entire system. Some of the possible tests are listed below:

a. FIREBERD #1 with local modem looped back.
b. FIREBERD #1 with remote low speed modem looped back.
c. FIREBERD #1 with remote loopback at the terminal 4 output of the remote multiplexer.
d. FIREBERD #1 to #2, full duplex or simplex.

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*The total errors counted will normally equal the sum of the errors caused by each pass through the link. If the error rate is extremely high, the measured error rate will be slightly less than the sum of the error rates for each direction because errors in one direction will occasionally cancel errors in the other direction.

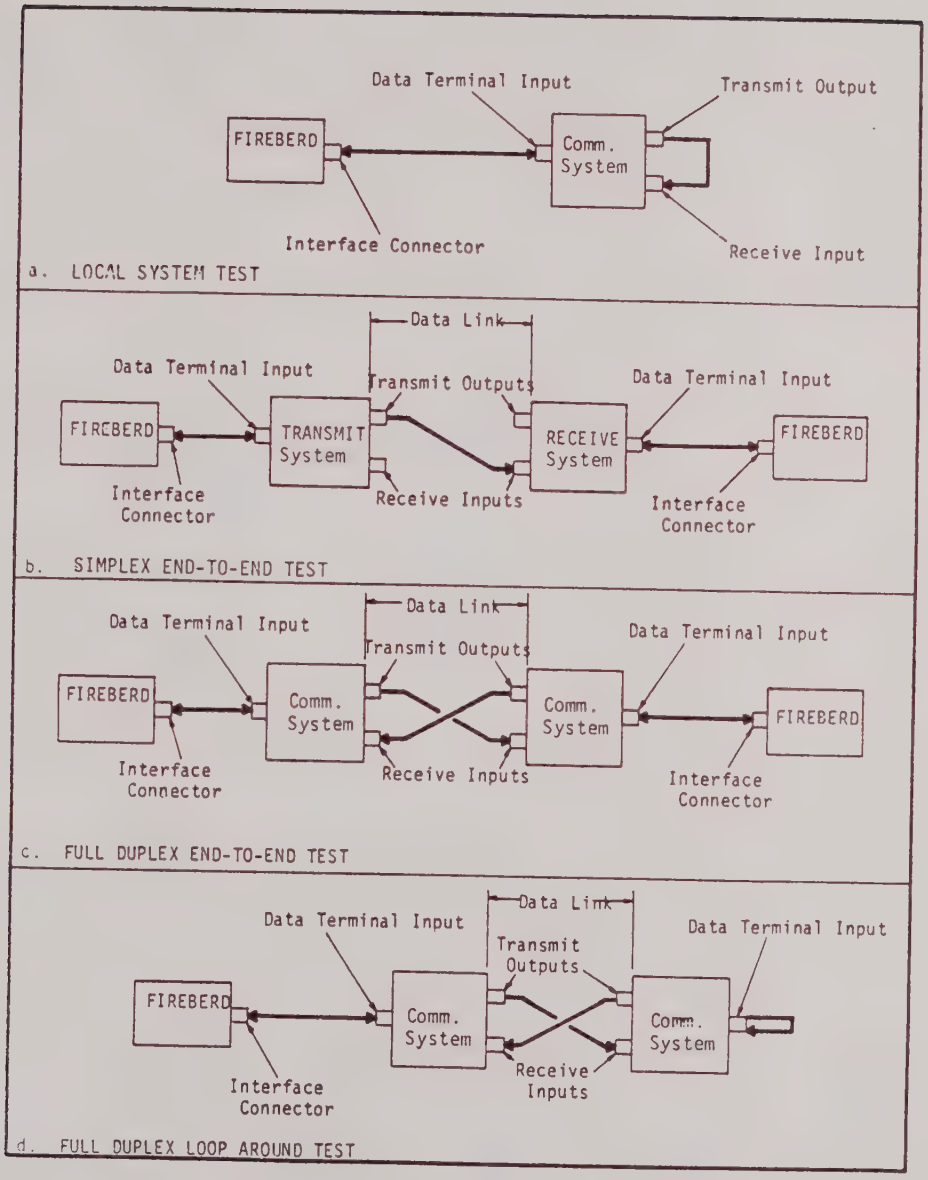

Figure 5-1. Measurement Modes

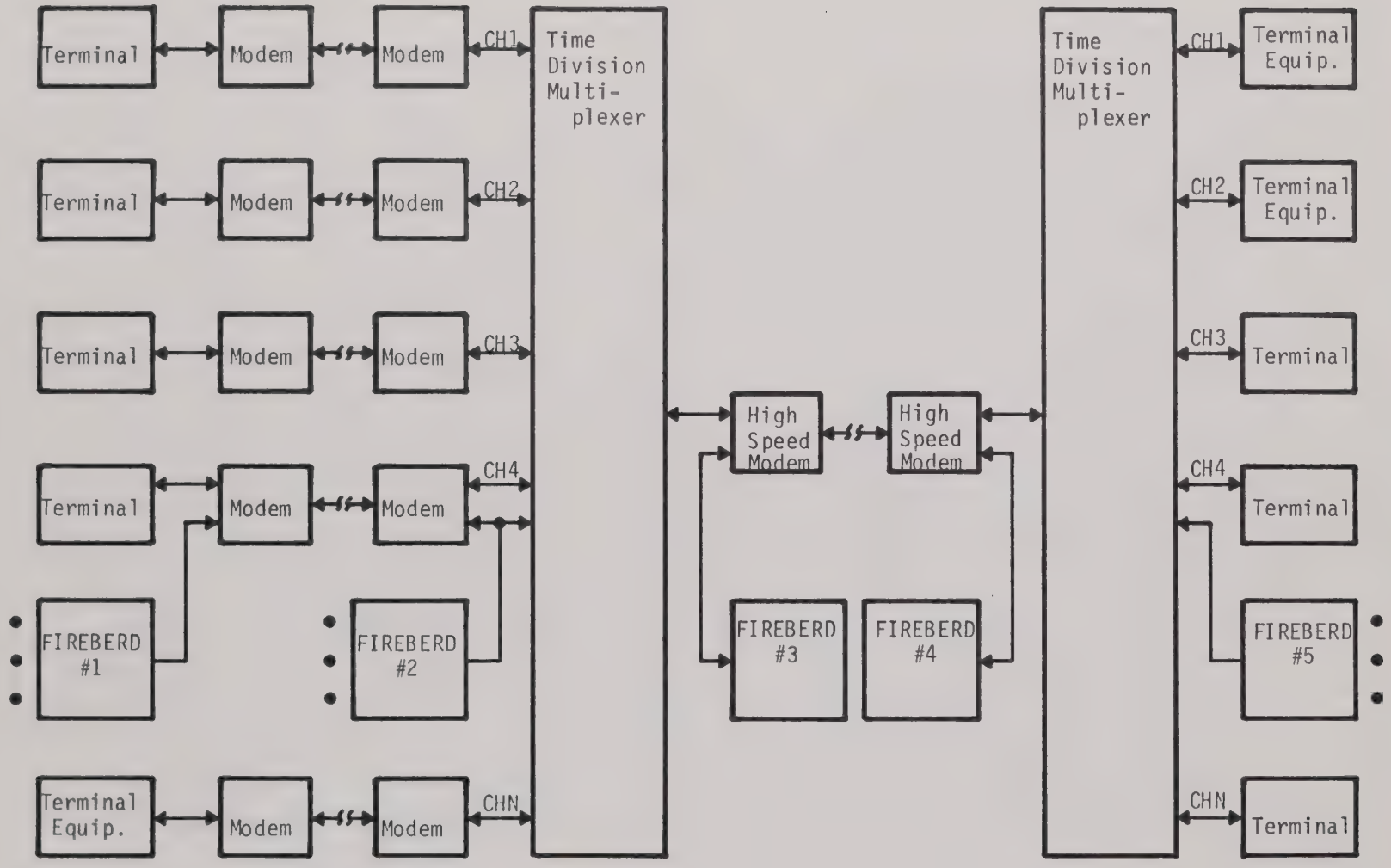

Figure 5-2 Measurement Configurations

e. FIREBERD #3 to #4, full duplex or simplex.

f. FIREBERD #2 to #5, full duplex or simplex. Note that FIREBERD #2 must act as a DCE in this case since the Multiplexer is configured to interface with multiple low speed modems (DCE's).

g. FIREBERD #1 to #5, full duplex or simplex. Note that FIREBERD #2 may be operated with a bridging interface to simultaneously measure performance part way through the system.

5.4 OPERATING CONSIDERATIONS

5.4.1 Synchronous DTE Timing Modes

The FIREBERD is capable of operating as synchronous Data Terminal Equipment (DTE) with many of its interface modules (exceptions include the RS-449 Bridging, RS-232 Asynchronous, and DS1 modules). Figure 5-3 shows the five possible synchronous timing modes.

Figure 5-3a shows the FIREBERD providing transmit timing and data at one of the standard internal rates or with an optional frequency provided in Fa, Fb, Fc, or Fd. Receive timing and data are provided by the DCE. Figure 5-3b shows the FIREBERD receiving external transmit timing from the DCE. The external timing is used to generate transmit timing and data which is sent back to the DCE. The DCE provides receive data and timing. No signal should be applied to the BNC input in this mode. Figure 5-3c shows the FIREBERD using timing supplied through the BNC connector to generate transmit clock and data. The DCE provides receive data and timing. Figure 5-3d shows the FIREBERD receiving external timing from the DCE and generating transmit data with this timing. This mode of operation is similiar to the mode shown in 5-3b except the DCE does not accept the transmit timing which accompanies the transmit data. Care must be used with this timing mode at very high speeds. The delay caused by the cable along with the delay in generating transmit data from the external transmit clock causes a phase shift between the transmit data received at the DCE and the transmit timing sent out by the DCE. At high

speeds, this delay may become a significant fraction of the data period and cause invalid clock-data phasing at the DCE. The individual interface specifications in Section 7 provide actual values for the delay between the received external clock and transmitted data. This information along with the cable length may be used to compute the maximum operating frequency for this timing mode.

Any of the timing configurations shown in Figure 5-3 may be used for simplex as well as full-duplex or loop-around testing. In simplex operation, either the transmit or the receive clock and data will not be used.

When the LOOP TEST switch is activated, the outgoing transmit clock and data outputs get connected to the receiver clock and data inputs. This allows the loop test to be performed with one of the internal standard frequencies, or an external transmit clock. If a loop test is performed with the GENERATOR CLOCK switch in the EXT position and no external clock is provided, no data will be generated and the test will be unsuccessful. In this case, the GENERATOR CLOCK ACTIVITY LED will be off, indicating the lack of a transmit clock.

When the TRANSMIT CLOCK INVERT switch (on the Interface Module) is in the NORM position, the phasing between the external transmit clock and transmit data, and the phasing between the outgoing transmit clock and data is as specified by the interface specification in use.* When the switch is in the INVERT position, both of these clock-data phase relationships are reversed.

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*Most interface specifications require transmit data to be valid on the falling edge of the transmit clocks.

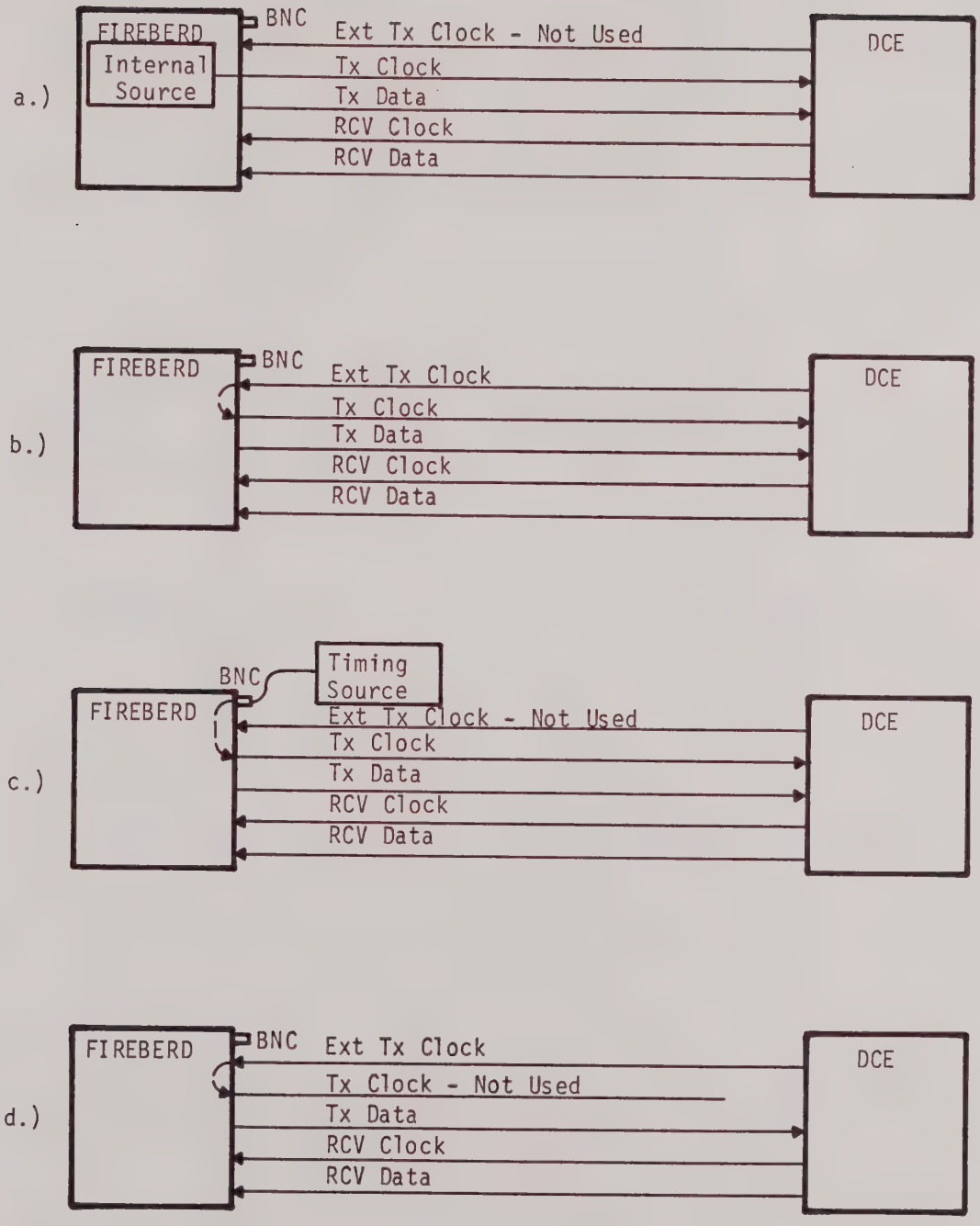

Figure 5-3 Synchronous DTE Timing Modes

When the RECEIVE CLOCK INVERT switch is in the NORM position, the FIREBERD expects to see receive clock-data phasing consistent with the interface specification in use.** In the INVERT position, the FIREBERD expects to see opposite phasing.

In loop test, both the TRANSMIT and RECEIVE CLOCK INVERT switches should be in the same position (either NORM or INVERT) to assure valid results.

5.4.2 Synchronous DCE Timing Modes

The FIREBERD is capable of acting as synchronous Data Communications Equipment (DCE) with the RS-232 DTE/DCE, V.35 DTE/DCE, and the RS-449 DTE/DCE Interface Adaptor Modules. Figure 5-4 shows six possible timing modes for DCE operation.

Figure 5-4a shows the FIREBERD providing receive clock and data to the DTE at one of the internal rates. The DTE provides transmit clock and data. Figure 5-4b is the same as 5-4a except the DTE uses the external transmit clock supplied by the FIREBERD to provide transmit timing. Figure 5-4c is the same as 5-4b except that the DTE does not provide transmit clock loop-around. In Figure 5-4d, timing is provided to the FIREBERD through the BNC connector (GENERATOR CLOCK switch in EXT position). This timing is used to generate receive clock and data, and is sent to the DTE for transmit timing. Figure 5-4e shows a configuration which is the same as 5-4d except that the DTE does not provide loop-around for the transmit clock.

The final timing mode is shown in Figure 5-4f. The DTE generates transmit clock and data at an internal rate and sends it to the test set which performs error analysis on it and loops the timing to generate receive data and timing.

** Most interface specifications require receive data to be valid on the falling edge of the receive clock.

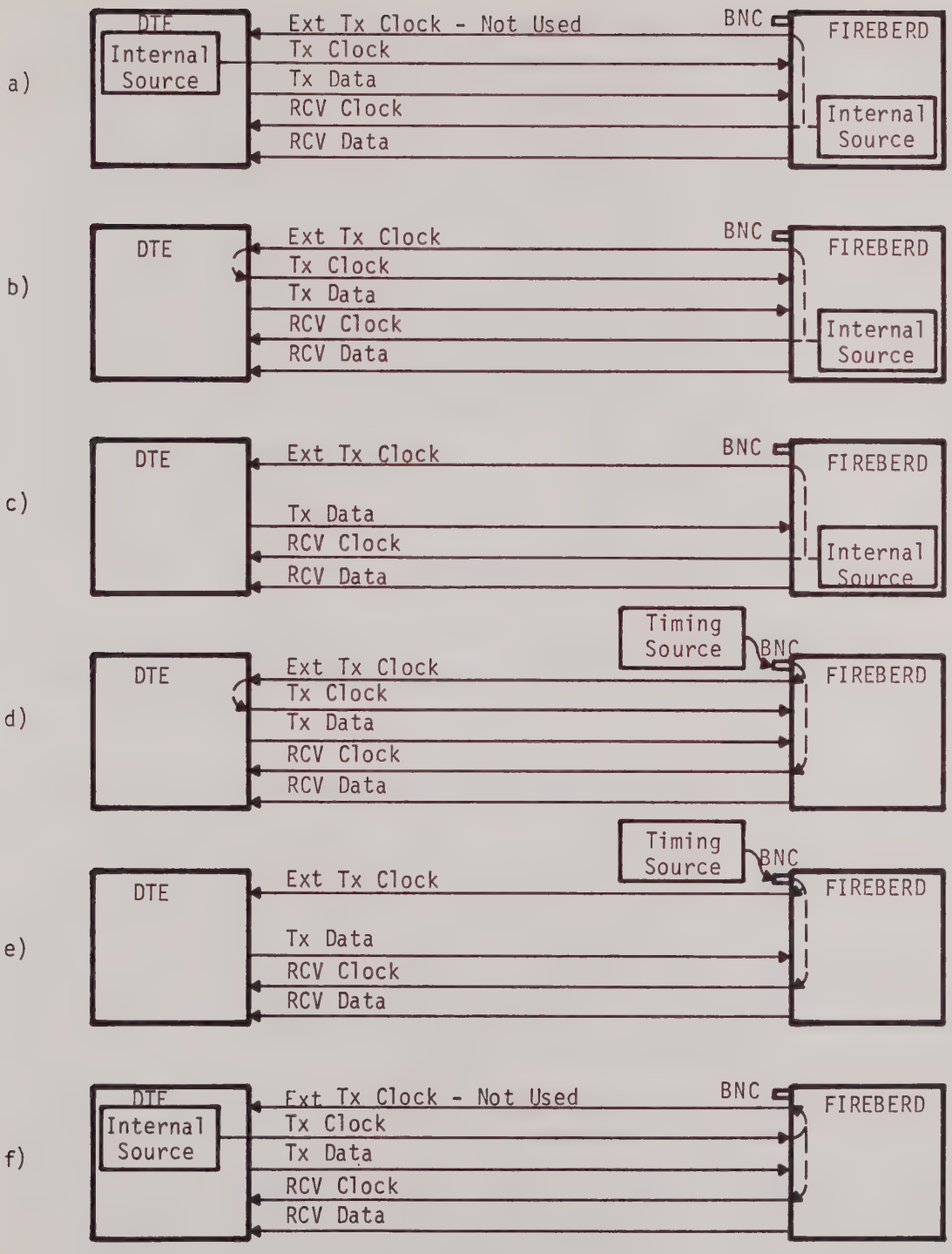

Figure 5-4 Synchronous DCE Timing Modes

In any of the timing modes where an internal clock source is shown inside the FIREBERD (5-4a, b, or c) the GENERATOR CLOCK switch should be set at one of the internal standard frequencies or Fa, Fb, Fc, or Fd. In any of the timing modes where the FIREBERD generates data from a clock supplied through the BNC input or from the DTE (5-4d, e, or f), the GENERATOR CLOCK switch should be in the EXT position.

Whenever the FIREBERD acts as a DCE and transmit timing originates in the FIREBERD or from its BNC input (Figure 5-4b, c, d, or e), a switch on the Interface Module prepares the FIREBERD to interface with a DTE which: 1) will loop the transmit timing back to the FIREBERD, 2) will not loop the transmit timing back to the FIREBERD.

5.4.3 Isochronous Or Self Clocked Timing Modes

The RS-232 Isochronous, DS1, T1, G.703, and Military Interface Adaptor Modules allow the FIREBERD to test systems where timing information is not transmitted separately from the data.

The DS1 Interface Adaptor (Model 40151) is designed to interface the FIREBERD to Bell T1 type systems. This Interface Adaptor recovers the receive timing from the receive data at the standard 1.544 Mbps rate. Timing from the transmit data signal may be developed by selecting: 1) the recovered receive clock signal, 2) the external clock input on the Interface front panel, 3) the external clock input on the FIREBERD rear panel, or 4) an optional 1.544 Mbps oscillator located in Fa, Fb, Fc, or Fd. Section 7.8 provides detailed information on the DS1 Interface Adaptor Module.

The T1 Interface Adaptor (Model 40365) is an enhanced version of the model 40151 DS1 Interface Adaptor. Model 40365 provides additional measurement capability and includes an internal 1.544 MHz oscillator. Timing for the transmit data signal may be developed by selecting 1) the interface module oscillator, 2) the recovered receive clock, 3) an external clock input

through the FIREBERD rear panel, or 4) an optional 1.544 Mbps oscillator located in Fa, Fb, Fc, or Fd. Section 7.14 provides detailed information on the T1 Interface Adaptor Module.

The RS-232 Isochronous Interface Adaptor is used to test asynchronous modems or systems which are capable of transmitting continuous data but do not employ transmit or receive clocks. This interface is capable of recovering a receive clock from an incoming continuous data stream at 75, 150, 300, 600, 1200, 1800, 2400, 3600, 4800, 7200, or 9600 baud. The recovered receive clock is passed to the FIREBERD along with the received data for error analysis. Timing to generate the transmit data may be provided from the modem or from an internal baud rate generator at any of the above rates. This Interface Adaptor is not capable of interfacing with systems which require or return start and stop bits mixed with the data. Section 7.11 provides detailed information on this Interface Adaptor.

For information on the G.703 or military Interface Adaptors, consult their respective separate manuals.

5.4.4 Asynchronous Timing Modes

The FIREBERD may be used with the RS-232 Asynchronous Character Interface Adaptor to test systems which employ bit-serial character interfaces. This interface inserts start, stop, and parity bits to the transmit data and removes these same bits from the receive data before performing error analysis. Most systems which employ character interfaces strip the start, stop, and parity bits off of the data before sending the data through the link. On the far end of the link, the start, stop, and parity bits are added back in. This interface should not be used to test systems which are transparent to start and stop bits since bit errors on these bits may cause loss of synchronization in the FIREBERD receiver. (The Isochronous Interface Adaptor should be used for these types of systems).

The Asynchronous Character Interface Adaptor is capable of acting as either a DTE or DCE. Detailed information on this Interface is provided in Section 7.12 of this manual.

5.4.5 Parameter Selection

5.4.5.1 Introduction

The following sections are provided to help the user select test parameters such as: BER test length, block length, pattern and synchronization mode.

5.4.5.2 BER Test Length Selection

The BER Test Length should chosen such that enough errors are accumulated during the measurement interval to produce a statistically reliable result. If the errors in the received data are statistically independent, a test length which collects more than 100 errors will provide a result within $\pm$ 20% of the true average error rate with a 94% confidence level. In some cases, errors may not be statistically independent. Differential encoders, self-synchronizing scramblers or other devices in the communications system, or channel characteristics may cause errors to occur in groups. If this is the case, the test length should be chosen to accumulate a larger number of errors to insure reliable results. Generally if Auto Mode is used or if the test length is set to be two orders of magnitude above the reciprocal of the anticipated BER, reliable results will be produced.

5.4.5.3 Block Length Selection

Block error measurements are useful in determining information about

the statistics or distribution of errors. If BER measurements are performed on the channel and block error measurements are also performed, information on the error distribution may be deduced. For example, if the BER is 1×10^{-5} over a 10^7 bit test interval and 100 10^5 bit blocks are received with only two block errors, it can be inferred that the errors are occurring in bursts. If the test were repeated with 10,000 10^3 bit blocks and only several block errors were counted, it can further be inferred that the errors are occurring in relatively short bursts ($<$1000 bits).

The errored-seconds measurement may be used to obtain a block length equal to the number of bits per second received. For example, at 56,000 bps, each second counted corresponds to a block of 56,000 bits and each error-second is a block error for the 56,000 bit block length.

5.4.5.4 Pattern Selection

The FIREBERD provides three patterns which are not pseudorandom in nature: mark, space, and 1:3 (1 mark followed by 3 spaces). These patterns may be used for signal tracing or error analysis. It should be noted that some communications systems may not function normally with some of these non-random patterns.

Five different pseudorandom patterns with the following lengths (in bits) are provided: $2^6-1=63$, $2^9-1=511$, $2^{11}-1=2047$, $2^{15}-1=32767$, $2^{20}-1=1048575$. Each of these patterns repeats with a time period equal to the pattern length (in bits) times the bit period (in sec/bit). Each 2^N-1 length pattern also has the property that no more than N sequential ones or N-1 sequential zeros will ever occur. Thus the longer pattern lengths will occasionally produce longer sequences of identical bits and thus longer sequences of data with no transitions. This is important for testing certain systems with clock recovery since long sequences of data with no transitions will stress clock recovery loops and may cause clock recovery problems.

5.4.5.5 Synchronization Mode Selection

The FIREBERD should normally be operated in Auto Sync Enable Mode. This allows the unit to synchronize to the incoming data and measure error rates up to 10^{-1}. In this mode, the unit will resynchronize and restart the test when the receiver detects more than 100 errors in any group of 1000 bits. Any true loss of synchronization will cause a 50% error rate to be detected by the receiver and thus cause a resynchronization.

Auto Sync Disable Mode is used when bursts of errors may produce error rates higher than 10^{-1} over 1000 bit intervals. In this mode, resynchronization is inhibited once synchronization has initially been obtained. Internal error counters will not overflow even at 100% error rates until the result becomes larger than 7 digits (display size). The internal counters used for BER measurements will not overflow under any circumstances. The disadvantage of using Auto Sync Disable Mode is that if a true loss of synchronization occurs* it will not cause a resynchronization. In this event, the measured BER will be 0.5. As a warning of possible loss of synchronization, the SYNC LOSS light will illuminate if the error rate exceeds 10^{-1} over the last 10^{5} bit interval in Auto Sync Disable Mode.

5.4.6 Interface

5.4.6.1 Interface Selection

The user should be careful to choose an Interface Adaptor Module which is appropriate for the system to be tested. This involves choosing a module which meets the appropriate Interface Specification, operates in the correct

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*Such as when a clock slip occurs.

mode (DTE, DCE, or Bridging), and functions in a compatible timing configuration (synchronous, asynchronous, or isochronous).

Interface Adaptor Modules are available with FIREBERD which meet the following standard Interface Specifications: EIA RS-232, EIA RS-449, CCITT V.35, and Bell 306, Bell DS1, WECO 303, CCITT G.703, and Military (MIL 188-144 and MIL 188C).** If the Interface Specification for the system under test is not one of the above, the user should consider whether the LAB Interface Adaptor may be used or if one of the standard Interface Adaptors may be used to interface with the system under test.

In most cases, the FIREBERD will need to be configured as Data Terminal Equipment (DTE) to test Data Communications Equipment (DCE). In these cases, a standard DTE or a DTE/DCE Interface Adaptor Module may be used.

Occasionally, the FIREBERD will need to interface with a communication system which is configured as a DTE. This will usually happen when the communication system to be tested must normally interface with other communications equipment. An example of this is shown in Figure 5-2 where the Time Division Multiplexer on the left side of the page must interface with modems which are configured as DCE. When the FIREBERD must act as a DCE to test a system configured as a DTE, one of the DTE/DCE Interface Adaptor Modules must be used.

In some situations, the user may wish to use a Bridging Interface Adaptor. These modules allow the FIREBERD to connect to an operating interface between two pieces of equipment. Switches on the module allow either the transmit data and clock or receive data and clock to be sent to the receiver section of the FIREBERD for error analysis. These modules do not allow the transmit section of the FIREBERD to be used. The test pattern(s)

**Consult TTC for an up-to-date list of available Interface Adaptor Modules.

passing through the system under test must originate from a FIREBERD or other test set located at the end(s) of the system. As an example, the FIREBERD #2 in Figure 5-2 could be operated with a Bridging Interface with the transmission being initiated by FIREBERD #1 or #5.

An Interface Adaptor with synchronous capability should be used whenever a clock signal accompanies the data at the interface for the system under test. Isochronous Interface Adaptors should be used to test systems where clock does not accompany the data and where the system is transparent to the data passing through it. Many low speed asynchronous modems fall in this category. Asynchronous Interface Adaptors should be used to test systems where clock does not accompany the data and where the system has an asynchronous character interface. Systems with this type of interface usually strip the start and stop bits off of the data before passing it through the link and add the start and stop bits back on at the remote end of the link.

5.4.6.2 Interface Operating Considerations

All Interface Adaptor Modules have some sort of operating speed limitations. Asynchronous and Isochronous Interfaces are designed to function at predefined operating frequencies or frequency ranges. The period of the received data bits must be within a specified percentage of the design frequency for proper operation. Section 7 specifies the appropriate limits. Interface Modules operating in a synchronous mode will have maximum operating speeds which are a function of cable length and other parameters for the particular interface in use - refer to Section 7 for details. Synchronous Interface Adaptor Modules provide CLOCK INVERT switches for inverting either the transmit or receive clocks. These switches should be placed in the NORM position unless it is known or suspected that the system to be tested employs non-standard data-clock phasing.

5.4.7 BNC Clock Input

The BNC CLock Input on the FIREBERD rear panel is automatically selected when a signal greater than 0.6 vpp is present at this input and the GENERATOR CLOCK switch is in the EXT position. To prevent false activation, the BNC Cap should be placed on the BNC connector whenever this input is not in use.

The BNC connector is AC coupled to a differential line receiver with a 2k input impedance from either input to ground. The receiver is designed to accept unipolar or bipolar, balanced or unbalanced signals greater than .6 vpp in amplitude. When a unipolar signal is used, it is advisable to provide a ground between the BNC shield and the rear panel ground test point or ground stud.

The high impedance of the line receiver input was provided to allow interfacing with RS-232, RS-423, and TTL drivers. A termination resistor equal to the characteristic impedance of the line which drives the BNC input should be used when the BNC input is used with a signal which has a high frequency or fast rise and fall time.

The differential voltage applied between the two BNC conductors should be kept less than 25 volts and the magnitude from either input to ground should be less than 25 volts. If the voltage at either BNC input exceeds 13 volts, the input impedance will drop from 2k ohms down to about 75 ohms due to internal diode protection circuits.

The minimum amplitude of the input signal should be increased from .6 volts pp to 1 volt pp at frequencies below 100 Hz.

5.4.8 Measurement Limitations

5.4.8.1 Error Analysis Mode

The FIREBERD 2000 is specified to run to frequencies down to 100 Hz for synchronous or isochronous operation. Operation below 100 Hz is possible with some restrictions. Below 100 Hz, the seconds, error seconds, and the print timer will count slower than normal and should not be used. For asynchronous operation with the 40234 Interface Adaptor, these same measurements will start to count slow at rates of 300 baud and below.

5.4.8.2 Frequency Mode

The frequency counter is specified to operate correctly down to 200 Hz. At rates below 150 Hz, measurement errors will occur.

5.5 OPERATING PROCEDURE

5.5.1 Error Analysis

The following step-by-step sequence may be followed to perform error analysis measurements with the FIREBERD. It is intended to serve as a guide and is not the only operating sequence.

1. Select a measurement configuration. If loop-around testing is to be performed, only one FIREBERD will be required. If end-to-end testing is desired, two FIREBERDS will be required and the procedure should be followed for the unit at each end of the link. Section 5.3 provides information on measurement configurations.

2. Set the FIREBERD for the appropriate line voltage. See Section 2.4 for details on line voltage selection.

3. If a printer is to be used, connect it to the appropriate printer interface and turn it on. Set the PRINT CONTROL EVENT switch to the desired position. If the IEEE-488 Interface is used, set the rear panel dip switches to the appropriate positions and properly configure the IEEE-488 printer. If the RS-232 Printer Interface is used, set the rear panel dip switch correctly (all switches up for PR-2000) and cycle the FIREBERD power. Section 6 provides information on the printer interfaces. Section 4.2 provides a description of each switch and indicator on the FIREBERD.

4. Select the appropriate Interface Module for the test. When making the choice, consider the following:

   The applicable interface specification; whether the FIREBERD will need to act as a DTE, DCE, or function in a bridging mode; whether the FIREBERD will run a synchronous, isochronous, or asynchronous timing mode.

Section 7 provides detailed information on each Interface Module.

5. Determine the timing mode. Set the switches on the Interface Module and the FIREBERD GENERATOR CLOCK switch to the appropriate positions. If the Interface Module has CLOCK INVERT switches, these switches should normally be set to the NORM position. Section 5.4.1 - 5.4.4 and Section 7 provide applicable information.

6. Connect the Interface Cable from the system under test to the Interface Module. Connect the power cord from the AC supply to the AC input on the FIREBERD rear panel. Connect the external clock to the rear panel BNC input if necessary; otherwise, place the shorting cap on

the BNC connector. Turn the FIREBERD power switch to the ON position.

7. Set the PATTERN, BLOCK LENGTH, BER TEST LENGTH, and AUTO SYNC switches to the desired positions. For full duplex testing, both FIREBERDS must have their PATTERN switches in the same position. Section 5.4.5 provides information on selection of these parameters. Section 4.2 provides a description for each switch.

   Place the RESULT HOLD/UPDATE/RESTART switch in the UPDATE position. Move the DISPLAY switch to the TIME and DATE positions to verify the time and date setting. Refer to Section 4.2.1, #10 for information on setting the time and date if necessary.

8. Set the RS (RTS)/RR (RLSD), and TR (DTR)/DM (DSR) switches to the positions required by the system under test. If in doubt, turn them ON.

9. Set the remaining switches as follows:

   AUDIO INDICATOR (rear panel) - as desired
   ERR INSERT - OFF
   MODE - ERROR ANALYSIS
   LOOP TEST - LOOP
   DISPLAY - ERR
   RESULT HOLD/UPDATE/RESTART - depress and release

   The FIREBERD should now be operating with its transmitter looped back to its receiver. The following indications should be present:

   a. The GEN CLK LED should be on: If it is not on and

the GENERATOR CLOCK switch is in the Fa, Fb, Fc, or Fd positions, no optional oscillator is present in the selected position. If the GENERATOR CLOCK switch is in the EXT position and no activity is present, the external clock is not being received. Check the levels of the signal applied to the BNC connector if BNC is in use. Check the Interface Module switch positions and verify the presence of an external clock at the Interface Module input if one is required for the timing mode in use. Refer to Sections 5.4.1 - 5.4.4 and Section 7 if necessary.

b. The RCV CLOCK (TX CLOCK for DCE operation) should be illuminated. The RCV DATA (TX DATA for DCE operation) should also be illuminated unless the PATTERN switch is in the Mk or SP position. If these are not present, verify that the Interface is not being operated above its maximum speed limit.

c. The SYNC LED should be illuminated. If it is not, check the Interface Module switches and maximum speed limit. Note that the DS1 Interface may not be run in loopback with recovered receive timing used for transmit timing.

d. The display should show zero errors.

Now depress the ERROR INSERT switch into the SINGLE position and verify that the error count on the display increments each time the switch is depressed. Once successful operation has been achieved in loopback, you are ready to operate through the system under test.

10. Place the LOOP TEST switch in the NORM position and

depress and release the RESTART switch. The RCV CLOCK (TX CLOCK for DCE operation), the RCV DATA (TX DATA for DCE operation), and the SYNC LED should all be illuminated. The test set is now operating through the communication system. Unless the system error rate is high ($>10^{-4}$) a 10^{-3} error rate may be inserted into the generated data stream to verify the data path. For loop-around testing, the inserted errors should be counted by the unit which inserted them. For end-to-end testing, errors inserted at one end should be counted at the other location.

11. Now that the unit is operating through the system, switch the ERROR INSERT to OFF. Depress and release the RESTART switch to start the test. If a printer is in use, depress and release the CONTROLS/AUTO/RESULTS switch into the CONTROLS position to document the test conditions. Note that changing the GENERATOR CLOCK, PATTERN, MODE, LOOP TEST, BLK LENGTH, BER TEST LENGTH, PWR, or Interface Module switches (on some interfaces) will cause a test restart, and a FORCED RESYNC printout.

5.5.2 Frequency Mode

Frequency may be measured by placing the MODE switch in the TX FREQ or RCV FREQ position. The frequency will be measured over on second intervals and displayed (in KHz) for any position of the DISPLAY switch other than the TIME or DATE positions.

The signal selected by the GENERATOR CLOCK switch will be the TX Clock for DTE operation or the RCV Clock for DCE operation. The clock signal input to the FIREBERD receiver will be the RCV Clock for DTE operation or the TX Clock for DCE operation.

The frequency of a signal input through the BNC connector may be measured by placing the GENERATOR CLOCK switch in the EXT position and setting the MODE switch to TX FREQ for DTE operation or RCV FREQ for DCE operation.

The user should not attempt to measure signals with frequencies less than 200 Hz or greater than 13 MHz.

SECTION 6
PRINTOUT FORMATS AND RS-232 PRINTER INTERFACE

6.1 INTRODUCTION

This section describes events which initiate data outputs, data output formats, and data buffering for the RS-232 and IEEE-488 printer interfaces. A physical and signal format description for the RS-232 interface is also provided.

Detailed information related to option 007 and 008 is not provided here. Option 007 allows remote control of the FIREBERD via the RS-232 printer interface in addition to the standard printer output capability. Option 008 provides all of the capability of option 007 and additionally provides an IEEE-488 Addressable Talker/Listener Interface which may be used for remote control or printer output. Information on each of these options is provided in manual ML 10491.

Information on the PR-2000 RS-232 thermal printer is provided in ML 10292.

6.2 EVENTS INITIATING DATA OUTPUTS AND DATA FORMATS

6.2.1 Introduction

The data output to the printer interface is dependent on the two PRINT CONTROL switches and the mode of operation (Error Analysis or Frequency). In the AUTO position of the PRINT CONTROL toggle switch, the data results are supplied to the printer interface on the occurrence of the appropriate test event dependent on the PRINT CONTROL EVENT switch. The following sections provide information on Control and Result outputs for Error Analysis and Frequency Modes.

6.2.2 Control Print

A Control Print is initiated by placing the PRINT CONTROL toggle switch into the CONTROLS position. The data output to the printer interface details the positions of all switches which set Error Analysis Mode test parameters. The output format for a Controls print is the same for Frequency and Error Analysis Mode.

Once a Controls print has been initiated, the movement of any test parameter switch will cause a row of 18 asterisks to be printed. This tells the operator that a test parameter has been changed since the last Controls printout or since power-up. The output of 18 asterisks is disabled when the EVENT switch is in the OFF position.

The following is the typical format of a Controls printout:

```
RTS:OFF DTR:OFF
 DTE INTERFACE
GEN CLK:  56KHZ
PRT EVT:    OFF
ERR INST:   OFF
BER T LTH: AUTO
PATTERN: 2↑20-1
BLK LTH:    400
AUTO SYNC:   EN
LOOP-TEST: LOOP
MODE:  ERR ANAL
```

Note: The FIREBERD prints out the interface type and the switch positions for some of the FIREBERD interface modules.

6.2.3 Error Analysis Results and Status Messages

In Error Analysis Mode, a Results print-out contains all of the ongoing test data, signaling lead information, the time and date that the print-out was initiated and the identification number of the FIREBERD unit. A Results

print is initiated manually by depressing the PRINT CONTROL toggle switch into the Results position. The manually activated Results print is not dependent on the EVENT switch.

In the AUTO position of the toggle switch, a data results print-out is initiated automatically, depending on the setting of the EVENT switch. With the EVENT switch in the OFF position, only manually activated Results or Control print-outs are available to the printer interface. In the ERR (Error) position, a print-out is initiated on the occurrence of an errored second and once every hour of the ongoing test. The 1, 10, and 30 minute positions initiate a print at the end of the respective test time interval. In the BER CYCLE position of the EVENT switch, data is sent to the printer interface at the completion of each BER test length as determined by the BER TEST LENGTH switch.

The following is a typical Error Analysis Results print-out:

```
LOOP
RTS:F DTR:F
DSR:F CTS:F RLS:F
BER 0.00E-05<1E06
4E3LT BLK      643
BLK ERR          0
ERR SEC          0
SEC              1
ERR              0
17:01:30 001 10/27
```

The top line of this print-out tells the operator that the FIREBERD is operating in the Loop Test Mode. The next two lines define the signaling lead status, with each lead being either True (On) or False (Off). The ongoing test has measured a BER of zero (BER 0.00E-05<) with the less than sign (<) showing that less than 100 errors have been received in the last 10^6 data bits. This line also tells the operator that the last BER update was measured over one million bits of data (1E06). At the time of this results print-out,

643 blocks had been received (643) with a Block Length of 4000 bits (4E3LT BLK). The next two lines define the Block Errors (BLK ERR) and the Errored Seconds (ERR SEC) as being zero (0). One test second (SEC 1) was recorded and no Errors (ERR 0). The last line shows the time as 5:01 PM and 30 seconds (17:01:30), the identification number as one (001) and the date as October 27 (10/27).

A Results print-out is also initiated when a result such as Errors, Blocks, or Block Errors overflows (>9,999,999 units). On the occurrence of an overflow, two asterisks are printed next to the unit that overflowed. Each Result print-out following the initial overflow has a single asterisk printed next to the overflowed value. If any one of the above units in the same Error Analysis test overflow 10 times, all automatic and manually activated result print-outs will be disabled. This function may be reset by restarting the test.

Note: All asterisks are cleared when the test is restarted.

Status Messages

In Error Analysis Mode, status messages are output to the printer on the occurrence of events which affect the test in progress. Some of the messages require that the test data by synchronized and the test running.

The following formats provide information on each of the status messages for the Error Analysis Mode:

1. The Power On message is sent to the FIREBERD printer interface when the FIREBERD is powered up. This message is not sent if the PRINT CONTROL EVENT switch is in the OFF position.
   PWR ON

NOTE: This message is also printed and the FIREBERD reset anytime the AC supply voltage returns from dropping outside of the specified input levels.

2. The Sync Acquired status message is output when the Error Analysis receiver section of the FIREBERD has synchronized to the incoming data. This message includes signaling information, the time that synchronization occurred, the identification number (ID#) and the date.

```
RL:  F   RR:  F   DM:  T
TR:  F   LL:  T   RS:  F
(Time)   (ID)     (Date)
SYNC ACQ
```

NOTE: A test parameter switch change causes a resynchronization to the incoming data and produces a Sync Acquired status message when synchronization is acquired.

3. The Sync Loss message is sent to the printer interface when the Error Analysis receiver section has lost synchronization to the incoming data. This message includes signaling information, the time and data that synchronization was lost and the ID number of the FIREBERD.

```
RL:  F   RR:  F   DM:  T
TR:  F   LL:  T   RS:  F
(Time)   (ID)     (Date)
SYNC LOSS
```

4. A Test Restart message is sent to the printer interface on the occurrence of a manually activated Test Restart (depress TEST RESTART) with the AUTO SYNC switch in the ENABLE position or when in Frequency Mode. The Test

Restart message includes the time and date that the switch was depressed and ID number of the instrument.

(Time) (ID) (Date)
TEST RESTART

5. A Forced Resync message is sent to the printer on the occurrence of a manually activated Test Restart (RESTART switch) with the AUTO SYNC switch in the DISABLE position or on a test parameter switch change. This message defines the time and date that the Error Analysis test was resynchronized and the test restarted, and the identification number of the FIREBERD.

(Time) (ID) (Date)
FORCED RESYNC

6. The Clock Loss message is output to the printer interface when the clock signal being used for the ongoing Error Analysis test is no longer detected. The instrument does not have to be synchronized to the incoming data to detect a Clock Loss.

The time and date that the signal was lost and the identification number of the instrument is included with this message.

(Time) (ID) (Date)
CLOCK LOSS

7. The Data Loss message is sent to the printer interface when transitions in the data signal being used for Error Analysis testing are no longer detected. The FIREBERD Data Error Analyzer does not have to be synchronized to the incoming data to send the Data Loss message. This

message includes the time and date that the signal was lost and the identification number of the instrument.

(Time) (ID) (Date)
DATA LOSS

8. A Signaling Change message may be sent to the printer interface on the occurrence of a change in the status of any signaling lead (depending on the particular interface). The state of each signaling lead is included in this message. The time and date that the change occurred along with the identification number and whether or not the instrument is in Loop Test is included in the print-out. FIREBERD 2000's are normally shipped with the signaling change print-out disabled. Consult the factory for information on how to enable this feature.

NOTE: FIREBERD must be in sync to initiate a Signaling Change message.

```
LOOP
RTS:F DTR:F
DSR:F CTS:F RLS:F
 7:02:42 001 10/21
SIGNALING CHG
```

9. The Buffer Full message is output to the printer interface when the FIREBERD printer buffer is unable to accept new data. (The buffer can contain approximately 16 error analysis print results before overflowing. See Section 6.3.) No more printer data is accepted into the buffer until it is down to 80% full.

BUFFER FULL

6.2.4 Frequency Mode

Results

In Frequency Mode a Results print out consists of the result of the frequency test (transmit or receive), whether or not the frequency was measured in Loop Test and the time, date, and the identification number of the instrument. A Results print is initiated manually in either the Transmit or Receive Frequency Modes by depressing the PRINT CONTROL toggle switch into the RESULTS position. A manually activated results print-out functions independently of the EVENT switch.

In the AUTO position, a frequency result may be initiated at 1, 10, or 30 minute intervals depending on the respective position of the EVENT switch. In Frequency Mode, the function of the BER CYCLE and ERR switch positions are equivalent to the OFF position of the EVENT switch.

The following is a typical results print-out in Frequency Mode:

```
12:46:12 000 10/27
TX FRQ    112.000K
LOOP
```

This message shows a Transmitter frequency of 112 kilohertz while in the LOOP Test Mode. The time is 12:46 pm and 12 seconds on October 27. The I.D. number of the FIREBERD is set to zero.

Status Messages

In Frequency Mode, a status message provides information pertaining to the ongoing frequency measurement. The following section provides information and formats on these messages:

1. The Power On message is output to the printer interface in the Frequency Mode when the FIREBERD Data Error Analyzer is powered up with a device attached to the printer interface.

   PWR ON

2. A Test Restart message is sent to the printer interface on the occurrence of a manually activated Restart (RESTART switch). Deprssing this switch causes a reset of all frequency counters similar to the 1 second up-date that occurs normally in Frequency Mode. This message includes the time and date the switch was depressed and the identification number of the instrument.

   (Time) (ID) (Date)
   TEST RESTART

3. The Clock Loss message is sent to the printer when the clock signal being input as the RCV CLOCK is inactive for more than 100 milliseconds. This message includes the time and date the signal was lost as well as the identification number of the instrument.

   (Time) (ID) (Date)
   CLOCK LOSS

4. The Data Loss message is sent to the FIREBERD printer interface when transitions in the receive data signal are not detected for more than 800 milliseconds. This message includes the time and date the signal was lost and the identification number of the instrument.

   (Time) (ID) (Date)
   DATA LOSS

5. A Buffer Full message is output to the printer interface when the FIREBERD printer buffer is unable to accept new data. This message is output only on the occurrence of the buffer reaching its full state. No further printer data is accepted into the buffer until it is down to 80% full.

BUFFER FULL

6.3 DATA BUFFERING

Both the RS-232 and the IEEE-488 interface receive their data through a 512 byte data buffer (FIFO). This buffer is capable of holding 16 error analysis data results before outputting a BUFFER FULL message. Once the buffer is full, it does not accept new data until it is down to 80% full. Data outputting to the printer interface continues until the buffer is completely empty or when the buffer is manually cleared. Clearing is accomplished by setting the printer EVENT switch to the OFF position. At this point the ongoing printed result contains erroneous data until that particular result is completed.

6.4 RS-232 PRINTER INTERFACE

6.4.1 General Description

This interface provides serial asynchronous data with levels, connectors, and pin-outs as specified by EIA standard RS-232C. The interface is set up such that the FIREBERD 2000 acts as Data Communications Equipment sending data to Data Terminal Equipment (the printer). Four signal lines are supported: signal ground, protective ground, Receive Data, and Data Terminal Ready (DTR).

When the FIREBERD is ready to output data, it looks at the DTR line for an ON condition. If DTR is not ON, the printer is not connected or turned on and no output is attempted. If DTR is ON, one data byte is transmitted on the receive data line. If the DTR line stays in the ON condition after this byte has been sent, another byte will be transmitted. In this manner, the FIREBERD will continuously output data bytes to the receive data line, inserting pauses whenever the DTR line goes to the OFF state. This allows the printer or DTE to stop the data flow while it takes time to print a line or store the data. Once the last byte has been transmitted and DTR goes to the ON condition, the data output is complete.

In order to compensate for printers which are slow in changing DTR to the OFF condition at the end of each line, the FIREBERD will wait .8 seconds after sending a carriage return before checking the state of the DTR lead. For faster responding printers such as the PR-2000, the printout time may be reduced by holding the CLK SET switch in the FAST position on power-up. This reduces the wait time from .8 seconds to 50 milliseconds.

6.4.2 Signal Format

Each FIREBERD is shipped with the RS-232 printer interface configured to run at 2400 baud (all RS-232 DATA FORMAT switches UP). Each data byte consists of one start bit followed by: 7 data bits, one even parity bit, and 2 stop bits.

The seven-bit American Standard Code for Information Interchange (ASCII) is used to code each character. Each data line is less than 20 characters long and ends with a carriage return (ASCII character CR). A linefeed (ASCII LF) is sent after each complete data output to cause a blank line to be printed for RS-232 operation.

The FIREBERD sends a carriage return character at the end of each line and expects the printer to perform both a carriage return and a linefeed before beginning the next line. For printers which do not automatically perform a linefeed after each carriage return the FIREBERD may be set to output a linefeed character after each carriage return by setting the appropriate switch on the RS-232 DATA FORMAT dip switch (refer to Table 4-1). Note that this switch is only read on power-up.

6.4.3 Connection To Other Devices

The RS-232 printer interface requires only 3 lines to operate properly (Data, DTR, and Ground). The Data line is output from the FIREBERD printer interface at pin 3 of the RS-232 printer connector. This signal consists of serial ASCII characters with start, stop, and parity bits.

The DTR (Data Terminal Ready) input is located at pin 20 on the RS-232 printer connector. This input is used to tell the FIREBERD when the printer is ready to accept data. When an ON signal is input at DTR (pin 20), the FIREBERD will begin outputting characters at the Data output (pin 3). Ground is located at pins 1 and 7 of the RS-232 printer connector.

CAUTION

If RS-232 Remote Control is provided (option 007 or 008), no connections should be made to pins 9, 10, 11, 18, and 25 of the RS-232 connector. When RS-232 Remote Control is provided, these pins are used as outputs for Interface Switching Unit Control. Each of these pins is either unassigned or reserved for data set testing by the EIA RS-232 specification. If a TTC PR-2000 or PR-1500 printer is used, no connections are made to these pins by the cable supplied with the printer. Consult the manual for option 007 and 008 (ML 10491) for additional details.

Table 6-2. Printer Output Abbreviations

Message	
ABER	Error Analysis, Average BER result
AUTO SYNC	Position of the AUTO SYNC switch (ENABLE, DISABLE)
BER	Error Analysis BER result
BER T LTH:	Position of the BER TEST LENGTH switch
BLK ERR	Error Analysis, Block Error result
BLK LTH:	Position of the BLK LENGTH switch
BUFFER FULL	Printer Data Buffer, is full
CLOCK LOSS	RCV CLK (DTE Mode) or TX CLK (DCE Mode) is not active
DATA INV	Incoming data is inverted
DATA LOSS	RCV DATA (DTE Mode) or TX DATA (DCE Mode) is not active
ERR	Error Analysis, Error result
ERR INST:	Position of ERROR INSERT switch, (10^{-3}, OFF, SINGLE)
ERR SEC	Error Analysis, Errored Seconds result
EXT BNC	Generator Clock is being input from the rear panel BNC connector
FORCED RESYNC	RESTART depressed with Auto Sync Disabled
GEN CLK:	Position of the GENERATOR CLOCK switch
LOOP	Test performed with LOOP TEST in the LOOP position
LOOP-TEST:	Position of the LOOP TEST switch
MODE:	Position of the MODE switch (ERR ANAL, RCV FREQ, TX FREQ)
NO SYNC	Error Analysis receiver is not synchronized to incoming data
PATTERN:	Position of the PATTERN switch
PRT EVT:	Position of the EVENT switch
PWR ON	Power applied to FIREBERD
RCV FREQ	Receive Frequency result
SEC	Error Analysis, seconds result

Table 6-2. Printer Output Abbreviations (Cont.)

SIGNALING CHG	Signaling lead changed
SYNC ACQ	Synchronization Acquired
SYNC LOSS	Synchronization Lost
TEST RESTART	TEST RESTART switch depressed
TX FREQ	Transmit Frequency result
12:46:12 001 10/27	Time (hours, minutes, seconds) Identification number Date (month, day)
**********	Test parameter switch changed since last Controls print-out or since power up
**	The respective test data overflow just occurred
*	Test data is an overflowed value
<	Less than 100 errors occurred during the BER measurement interval

SECTION 7
INTERFACE ADAPTOR MODULES

7.1 INTRODUCTION

Interface Adaptor Modules are used to interface the FIREBERD with any of several different types of data communications circuits. With the exception of the rear panel EXT CLK IN BNC connector and Printer Interfaces, all signals exchanged between the FIREBERD and the "outside world" must pass through an Interface Adaptor Module.

Section 7 contains descriptions, specifications and operating instructions for most of the available Interface Adaptors. The following Interface Adaptor Modules are included:

7.2 RS-449 DTE Interface Adaptor (Models 40180 and 40263)
7.3 RS-449 DTE/DCE Interface Adaptor (Model 40200)
7.4 RS-449 Bridging Interface Adaptor (Model 40198)
7.5 V.35/306 DTE Interface Adaptor (Model 40138)
7.6 V.35/306 DTE/DCE Interface Adaptor (Model 40202)
7.7 WECO 303 Interface Adaptor (Model 40182)
7.8 DS1 Interface Adaptor (Model 40151)
7.9 RS-232 DTE Interface Adaptor (Model 40112)
7.10 RS-232 DTE/DCE Interface Adaptor (Model 40236)
7.11 RS-232 Isochronous/Synchronous DTE Interface Adaptor (Model 40232)
7.12 RS-232 Asynchronous DTE/DCE Character Interface Adaptor (Model 40234)
7.13 Lab Interface Adaptor (Model 40204)
7.14 T1 Interface Adaptor (Model 40365)

Separate manuals are available for CCITT G.703, Military, and other newly developed Interface Adaptors - consult TTC for additional information.

7.2 RS-449 DTE INTERFACE ADAPTOR MODULE (MODELS 40180 and 40263)

7.2.1 Introduction

The Model 40180 and 40263 DTE Interface Adaptors allow the FIREBERD to test synchronous communications channels utilizing EIA Standard RS-449. These Interface Adaptors enable the FIREBERD to act as a Data Terminal Equipment (DTE) for use in testing Data Communications Equipment (DCE).

Data is exchanged in a serial binary format with synchronous clock signals. Data, clock, signaling, and other connections are made through a standard 37-pin female "D" connector; optional 37-conductor male-to-male cables are available from TTC.

The RS-449 Interface Adaptors can operate with either of the two electrical interfaces specified by EIA Standard RS-449. Line drivers and receivers conforming to either RS-442 or RS-423 can be selected by switch. The following section will provide functional specifications and descriptions of the RS-449 DTE Interface Adaptor.

7.2.2 Functional Description

The RS-449 DTE Interface Adaptor is used to connect between the TTL signals used within the FIREBERD and signals conforming to EIA Standards RS-422, RS-423, and RS-449. The Interface Adaptor has three modes of operation:

1. RS-423 - In this mode of operation, the line drivers and receivers are configured to operate with bipolar unbalanced signals at bit rates up to 100 Kb/s. Signals are transmitted over the (A) lead of each signal pair with the (B) lead grounded.

2. RS-442 Terminated - In this mode the line drivers and receivers are configured to operate with unipolar balanced signals at bit rates up to 10 Mb/s. The line receivers have 100 ohm terminating resistors between the (A) and (B) leads of the Receive Data (RD), Receive Timing (RT), and Send Timing (ST) inputs.

3. RS-422 Unterminated - In this mode, the line drivers and receivers are configured to operate with unipolar balanced signals at bit rates up to 10 Mb/s. Designed primarily to operate with short cable lengths or with low bit rates, no terminating resistors are provided.

Timing for the Terminal Timing (TT) and Send Data (SD) outputs can be obtained from any of three sources:

a. The FIREBERD internal clock frequencies including FA, FB, FC, and FD if so equipped.

b. The Interface Send Timing (ST) input. Note that the FIREBERD GENERATOR CLOCK switch must be set to the "EXT" position.

c. The rear panel BNC connector. If the GENERATOR CLOCK switch is in the "EXT" position and a signal is applied to this input.

7.2.3 Signaling

The following signals are supported by the RS-449 DTE Interface Adaptor and the FIREBERD:

1. Request to Send (RS) - controlled by FIREBERD front panel switch.

2. Clear to Send (CS) - displayed on FIREBERD front panel.

3. Receiver Ready (RR) - displayed on FIREBERD front panel.

4. Terminal Ready (TR) - tied in the ON condition for Model 40180 controlled by FIREBERD front panel switch for Model 40263.

5. Data Mode (DM) - displayed on FIREBERD front panel.

6. Terminal In Service (IS) - tied in the ON condition.

7. New Signal (NS) - tied in the OFF condition

8. Select Frequency/Signaling Rate Selector (SF/SR) - tied to the ON condition.

9. Local Loopback (LL) - tied in the OFF condition.

10. Remote Loopback (RL) - tied in the OFF condition.

11. Select Standby (SS) - tied in the OFF condition.

12. Test Mode (TM) - displayed on the FIREBERD front panel (Model 40263 only).

7.2.4 Switches and Indicators

The following switches and indicators are found on the RS-449 DTE Interface Panel:

1. 423/422 UNTERM/422 TERM - Selects the operating mode of the Interface Adaptor as described in Section 7.2.2.

2. TX CLK NORMAL/INVERT - Selects the phase relationship between the Send Timing (ST), Terminal Timing (TT) and the Send Data (SD) signals. Note that the NORMAL position selects the phase relationships specified in RS-449 (falling edge valid).

3. RCV CLK NORMAL/INVERT - Selects the phase relationship between the Receive Timing (RT) and the Receive Data (RD) signals. Note that the NORMAL position selects the phase relationship specified in RS-449 (falling edge valid).

4. NON STD TIMING - This lamp is illuminated when either or both of the CLK NORMAL/INVERT switches is set to the INVERT position.

7.2.5 Loop Test

The Interface Adaptor contains a relay which allows testing of the Interface Adaptor and FIREBERD data and clock signal paths. When the FIREBERD front panel LOOP TEST switch is placed in its lower position (LOOP), Terminal Timing (TT) is connected directly to Receive Timing (RT) and Send Data (SD) is connected directly to Receive Data (RD) by the relay, completing the loop path.

The interface cable need not be removed to perform the Loop Test as the TT, RT, SD, and RD connector pins are electrically isolated from all Interface Adaptor circuitry. No other signals are affected by the Loop Test.

7.2.6 FIREBERD Test Points

This section describes the relationship between signals at the interface connector and signals at the FIREBERD rear panel test points. The

test points provide TTL-level representations of the signals at the interface connector. A logic HI is a voltage greater than 2.5 volts and a logic LO is a voltage less than 0.4 volts.

RCV DATA/TX DATA: This test point will be a logic HI when the Receive Data (RD) signal is a Mark. The test point will be at a logic LO when RD is a Space.

RCV TIMING/-: When the RCV CLK switch is in the NORMAL position, the test point is at a logic HI when the Receive Timing (RT) is in the ON condition and is at a logic LO when RT is OFF. When the RCV CLK switch is in the INVERT position, the test point is at a logic HI when RT is in the OFF condition and at a logic LO when RT is ON.

TX DATA/RCV DATA: This test point will be at a logic HI when Send Data (SD) is a Mark and will be at a logic LO when SD is a Space.

SEND TIMING/TERM TIMING: For Model 40180, the test point will be at a logic HI when Send Timing (ST) is in the OFF condition and will be at a logic LO when ST is ON. For Model 40263, the test point will be at a logic HI when ST is in the ON condition and will be at a logic LO when ST is OFF. Use of the TX CLK INVERT switch will not affect these relationships.

TERM TIMING/RCV TIMING: For Model 40180, the test point will be at a logic HI when Send Timing (ST) is in the OFF condition and will be at a logic LO when ST is ON. For Model 40263, the test point will be at a logic HI when ST is in the ON condition and will be at a logic LO when ST is OFF. Use of the TX CLK INVERT switch will not affect these relationships.

7.2.7 Specifications

RS-449 Category 1 Circuits
(RS-423/RS-422 TERM/RS-422 UNTERM):

Send Data (SD)
Receive Data (RD)
Terminal Timing (TT)
Send Timing (ST)
Receive Timing (RT)
Request to Send (RS)
Clear to Send (CS)
Receiver Ready (RR)
Terminal Ready (TR)
Data Mode (DM)

RS-449 Category 2 Circuits (RS-423 only):

Terminal In Service (IS)
New Signal (NS)
Select Frequency/Signaling Rate Selector (SF/SR)
Local Loopback (LL)
Remote Loopback (RL)
Select Standby (SS)
Test Mode (TM)

RS-422 Data Mark (binary 1), Control Lead OFF:
Lead (A) more negative than Lead (B)

RS-422 Data Space (binary 0), Control Lead ON:
Lead (A) more positive than Lead (B)

RS-423 Data Mark (binary 1), Control Lead OFF:
negative polarity

RS-423 Data Space (binary 0), Control Lead ON:
positive polarity

RS-422 Line Drivers:
Output differential voltage: 2.0 volts minimum
Short circuit current 150 mA maximum
Output rise time: 20 nsec maximum

RS-423 Line Drivers:
Output voltage: ± 3.5 volts minimum
Short circuit current: 150 mA maximum
Output rise time: 120 nsec typical (not slew rate limited)
for Model 40180, 1 microsecond typical for Model 40263

RS-422 Terminated Line Receivers:
Load impedance: 100 ohms ± 10%
Differential input threshold voltage: ± 0.25 volts

RS-422 Unterminated Line Receivers
Load impedance: 4000 ohms minimum for Model 40180
2000 ohms nominal for Model 40263
Differential input threshold voltage: ± 0.25 volts

RS-423 Line Receivers:
Load Impedance: 2000 ohms minimum
Input threshold voltage: ± 0.25 volts

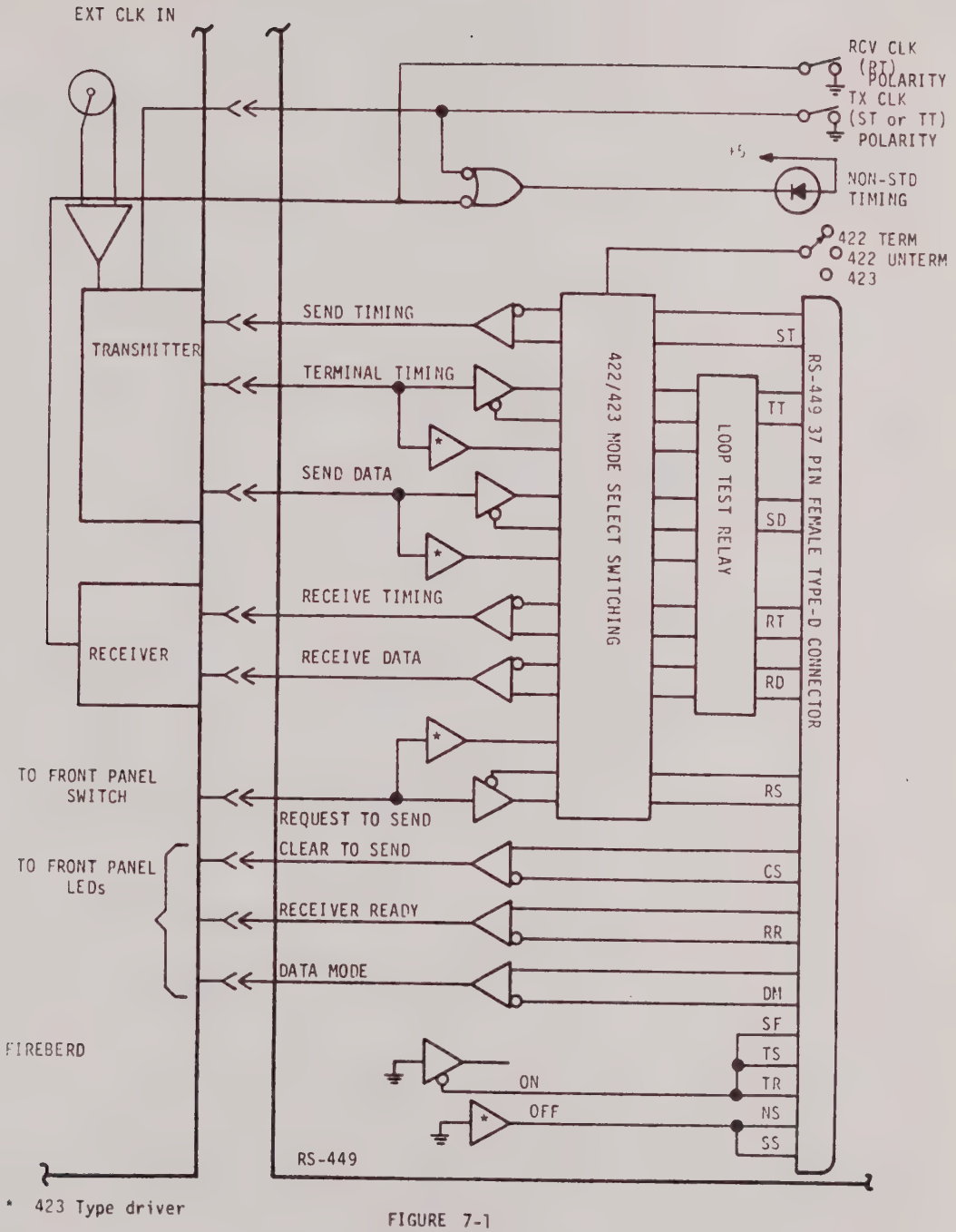


FIGURE 7-1
RS-449 INTERFACE
MODULE

TABLE 7-1

RS-449 CONNECTOR PIN ASSIGNMENTS

PIN	CIRCUIT	449 DESCRIPTION	COMMENT
1	SHIELD	Ground	internally connected to 27, 37, 19, 30
2	SI	Signaling rate indicator	open
3	SPARE	Spare	open
4	SD (A)	Send Data	output
5	ST (A)	Send Timing	input
6	RD (A)	Receive Data	input
7	RS (A)	Request to Send	output
8	RT (A)	Receive Timing	input
9	CS (A)	Clear to Send	input
10	LL	Local Loopback	423 output tied OFF
11	DM (A)	Data Mode	input
12	TR (A)	Terminal Ready	422/423 output tied ON *
13	RR (A)	Receiver Ready	input
14	RL	Remote Loopback	423 output tied OFF
15	IC	Incoming Call	open
16	SF/SR+	Select Frequency/ Signaling Rate Selector	423 output tied ON
17	TT (A)	Terminal Timing	output
18	TM	Test Mode	input
19	SG	Signal Ground	
20	RC	Receive Common	
21	SPARE	Spare	open

*Model 40180 only (See 7.2.3)

TABLE 7-1 (Cont.)

RS-449 CONNECTOR PIN ASSIGNMENTS

PIN	CIRCUIT	449 DESCRIPTION	COMMENT
22	SD (B)	Send Data	output
23	ST (B)	Send Timing	input
24	RD (B)	Receive Data	input
25	RS (B)	Request to Send	output
26	RT (B)	Receive Timing	input
27	CS (B)	Clear to Send	input
28	IS	Terminal in Service	423 output tied ON
29	DM (B)	Data Mode	input
30	TR (B)	Terminal Ready	output
31	RR (B)	Receiver Ready	input
32	SS	Select Standby	423 output tied OFF
33	SQ	Signal Quality	open
34	NS	New Signal	423 output tied OFF
35	TT (B)	Terminal Timing	output
36	SB	Standby Indicator	open
37	SC	Send Common	

7.3 RS-449 DTE/DCE INTERFACE ADAPTOR MODULE - MODEL #40200

7.3.1 Introduction

The RS-449 DTE/DCE Interface Adaptor has been designed according to the Electronic Industries Association (EIA) Standard RS-449 (November, 1977). This interface enables a FIREBERD to act as a Data Terminal Equipment (DTE) for use in testing Data Communications Equipment (DCE). With the use of a special adaptor cable (included) the FIREBERD can be configured as Data Communications Equipment (DCE). The data is exchanged in a serial binary format with a synchronous clock.

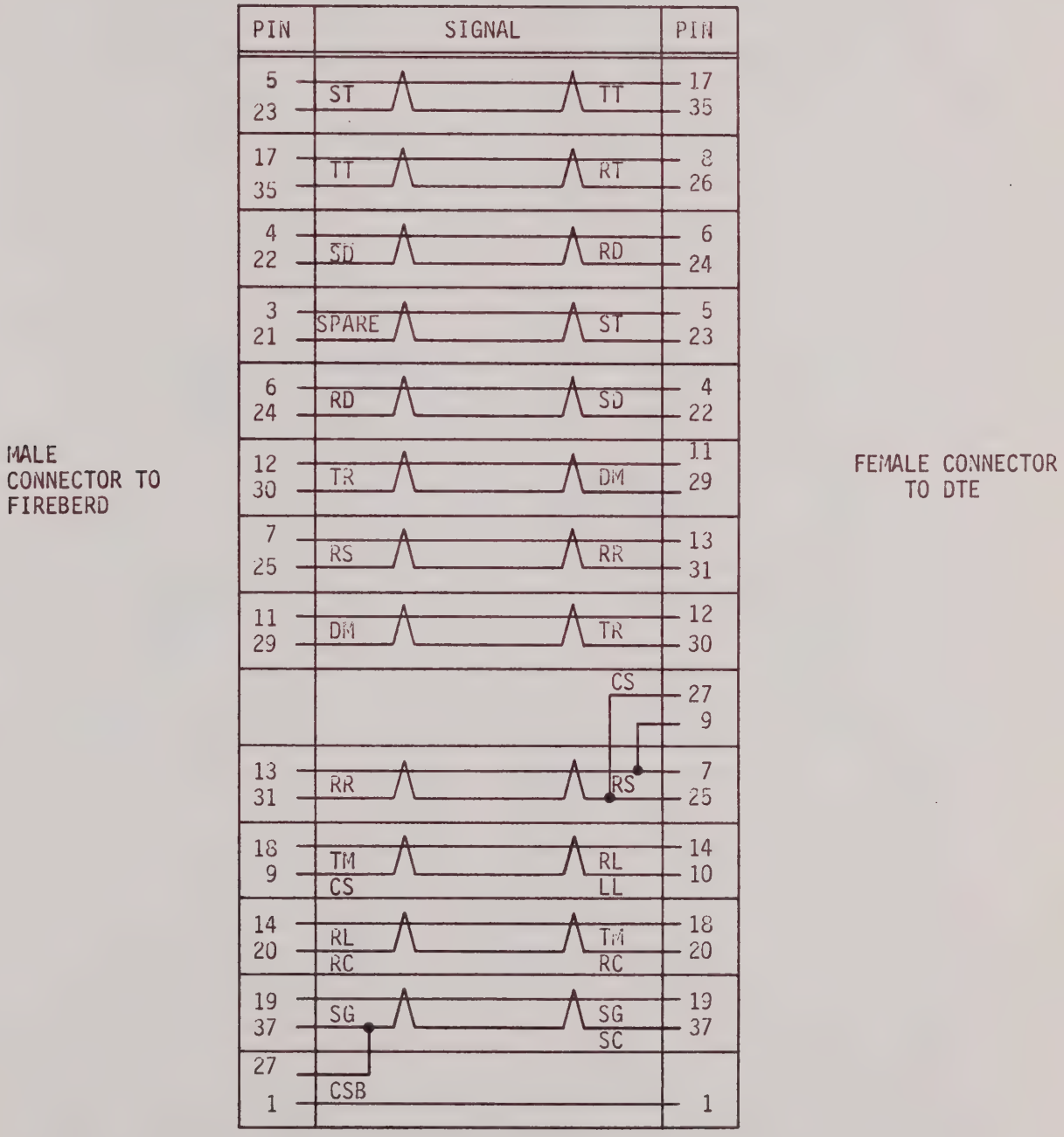
The RS-449 Specification describes two categories of signals: Category 1 and Category 2. The specification allows Category 1 circuits to be implemented with either RS-422 (balanced) or RS-423 (unbalanced) drivers. All Category 2 circuits are specified to be the RS-423 type.

The RS-449 DTE/DCE Interface Adaptor converts signals with characteristics specified by the RS-449 interface specification to the TTL signals used by the FIREBERD. The following sections provide a functional description of the RS-449 DTE/DCE Interface Adaptor.

7.3.2 Functional Description - DTE Operation

In a typical RS-449 circuit, the DCE supplies timing to the DTE (FIREBERD) on the ST (Send Timing) leads. With FIREBERD's GENERATOR CLOCK switch in the EXT position, FIREBERD will generate SD (Send Data) and TT (Terminal Timing) coincident with the clock received on the ST leads (see Figure 7-3). With FIREBERD's GENERATOR CLOCK switch set for any of the internal rates (including FA, FB, FC, or FD if so equipped), the FIREBERD will ignore the ST leads and generate SD and TT coincident with the selected internal rate (see Figure 7-4). Data and clock are received on the RD (Receive Data) and RT (Receive Timing) leads respectively for BER measurement.

FIGURE 7-2 DCE CABLE FOR RS-449 INTERFACE



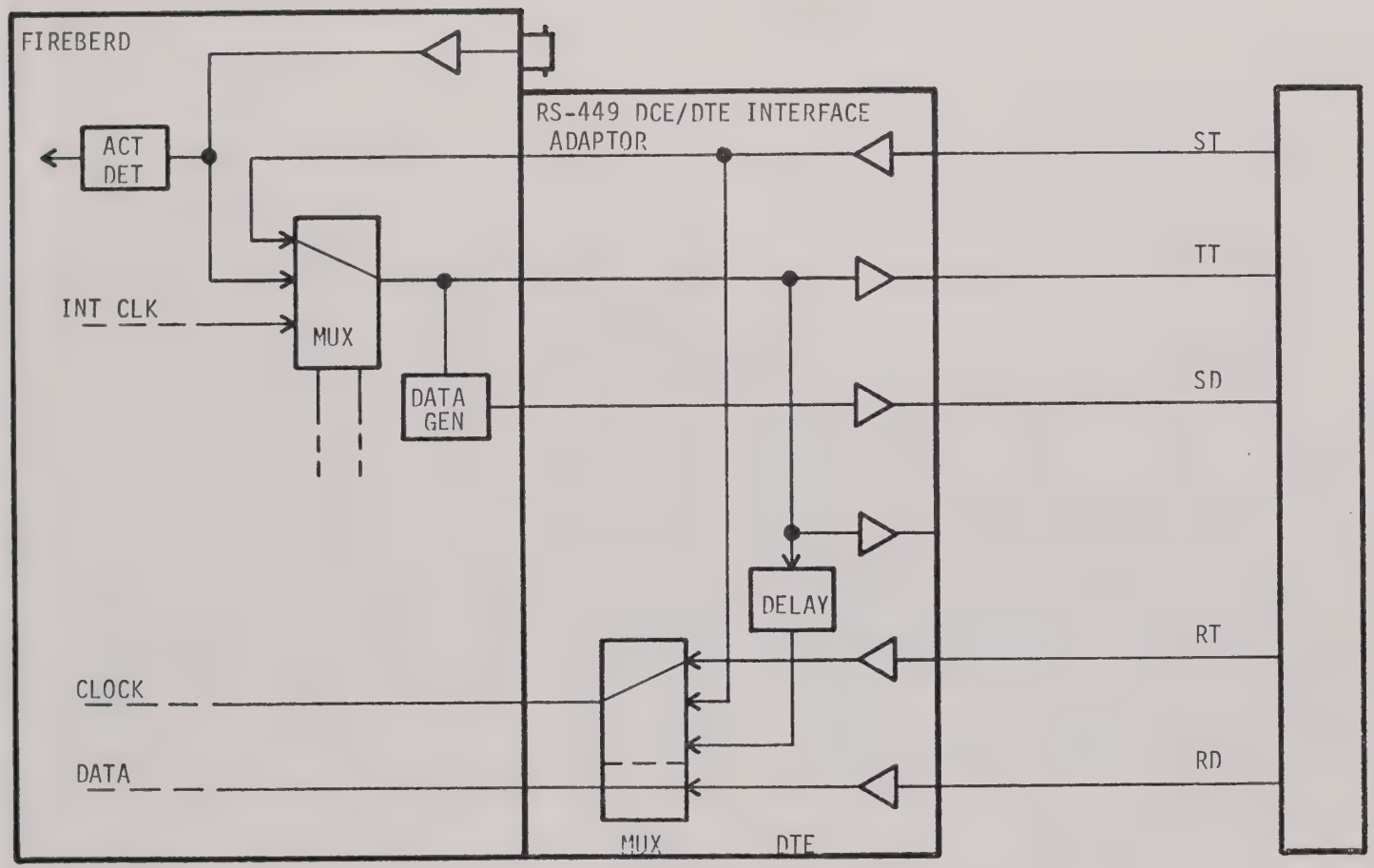


FIGURE 7-3 DTE-EXTERNAL TIMING

INTERFACE: "DTE" POSITION

FIREBERD: "EXT" POSITION

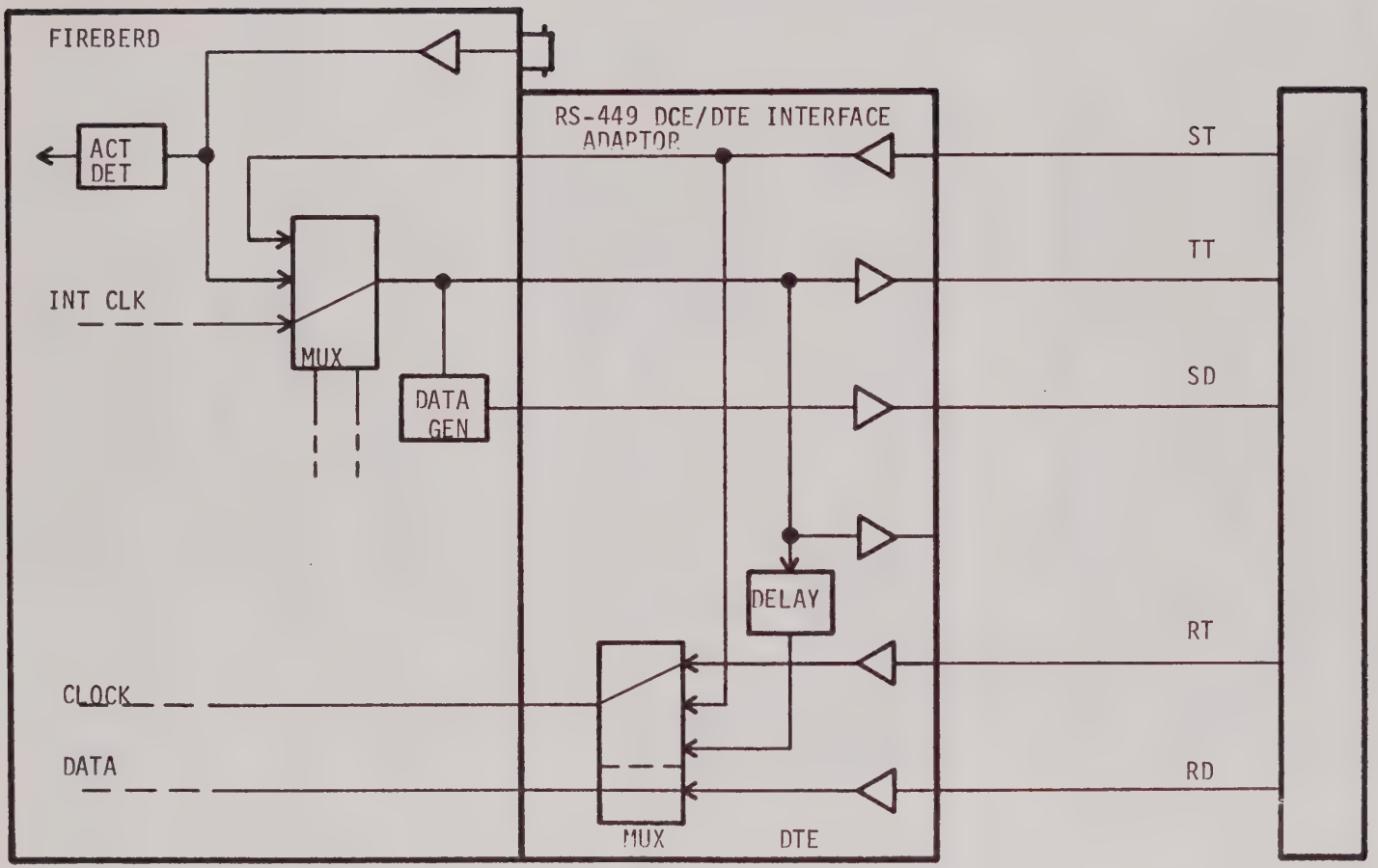


FIGURE 7-4 DTE-INTERNAL TIMING

(FIREBERD: "2.4, 4.8, ..., F_C, F_D")

Two multi-function clock invert switches are provided on the RS-449 DTE/DCE Interface Adaptor panel. As a DTE, setting the TRANSMIT CLOCK INVERT switch to the INV (up) position causes SD to be valid on the rising edge of the selected clock source instead of the falling edge (Normal-middle position). By setting the TRANSMIT CLOCK INVERT switch down, the transmit clock is unaffected and LL (Local Loopback) is turned on. As a DTE, setting the RECEIVE CLOCK INVERT switch to the INV (up) position causes FIREBERD to expect valid data (RD) on the rising edge of the RT clock instead of the falling edge (Normal-middle position). By setting the RECEIVE CLOCK INVERT switch down, the receive clock is unaffected and RL (Remote Loopback) is turned on.

Two toggle switches on the FIREBERD front panel allow RS (Request to Send) and TR (Terminal Ready) to be turned on and off. CS (Clear to Send), RR (Receiver Ready), and DM (Data Mode) are received and their status displayed on the front panel of the FIREBERD.

A loop test switch is provided on the front panel of the FIREBERD which will, using relays, connect the transmit clock and data outputs to the receive clock and data inputs. User connections do not have to be removed during a loop test. External timing for the loop test can be provided on the ST leads (DCE source) or through the rear panel BNC connector. Loop test tests the actual drivers and receivers used during normal operation.

7.3.3 Functional Description - DCE Operation

The FIREBERD RS-449 DCE/DTE Interface Adaptor can easily be configured to look like a DCE (Data Communications Equipment) for testing of DTE (Data Terminal Equipment) by using a special adaptor cable (included).

In a typical RS-449 circuit, the DCE (FIREBERD) supplies timing to the DTE on the ST (Send Timing) leads. The DTE will return to the DCE (FIREBERD), SD (Send Data), and TT (Terminal Timing). Two DCE modes are

selectable on the interface panel: DCE TT and DCE ST. In the DCE TT position (see Figure 7-5), SD and TT are sent to the receive section of the FIREBERD for BER measurement. In the DCE ST position (see Figure 7-6) SD and the internally generated ST are sent to the receive section of FIREBERD for BER measurement. With FIREBERD's GENERATOR CLOCK switch set to the EXT position, RD (Receive Data) and RT (Receive Timing) will be generated coincident with TT (Terminal Timing) from the DTE (this assumes the DTE can generate TT independent of ST) or from the rear panel BNC connector. With the GENERATOR CLOCK switch set to any of the internal rates (including FA, FB, FC, or FD, if so equipped) FIREBERD will generate RD and RT coincident with the chosen internal rate.

Two clock invert switches are provided on the RS-449 DTE/DCE Interface panel. All DCE functions are shown in parenthesis on the interface panel. As a DCE, the TRANSMIT CLOCK INVERT switch provides two functions. Setting the TRANSMIT CLOCK INVERT switch up causes FIREBERD to expect valid SD (Send Data) on the rising edge of the selected clock source instead of the falling edge (Normal-middle position). Setting the TRANSMIT CLOCK INVERT switch down turns on TM (Test Mode) with no inversion of the clock. Setting the RECEIVE CLOCK INVERT switch up causes FIREBERD to generate a valid RD on the rising edge of RT instead of the falling edge (Normal-middle position). As a DCE the RECEIVE CLOCK INVERT switch has no secondary function.

At the DTE end of the adaptor cable, CS (Clear to Send) is tied directly to RS (Request to Send). Two toggle switches on the front panel of the FIREBERD allow RR (Receiver Ready) and DM (Data Mode) to be turned on and off. TR (Terminal Ready), RS (Request to Send), LL (Local Loopback), and RL (Remote Loopback) are received and their status displayed on the front panel of the FIREBERD.

The LOOP position of the TEST switch on the front panel of the FIREBERD will, using relays, connect the clock and data drivers to the clock and data receivers. User connections do not have to be removed during a loop test. During a loop test, the ST driver still sends timing to the DTE.

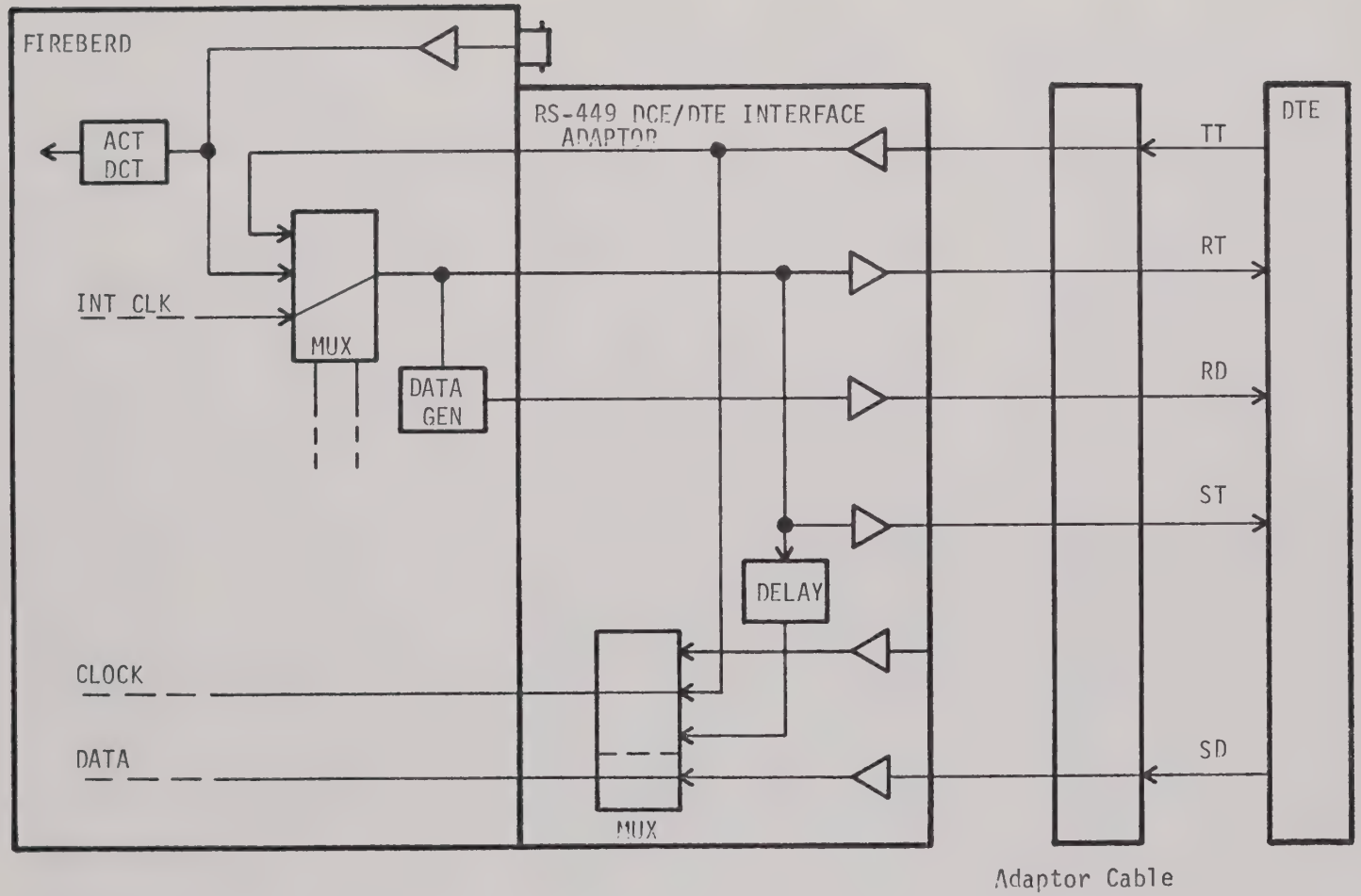


FIGURE 7-5 DCE-TT

INTERFACE: "DCE (TT)" POSITION

FIREBERD: "2.4, 4.8,..., F_C, F_D"

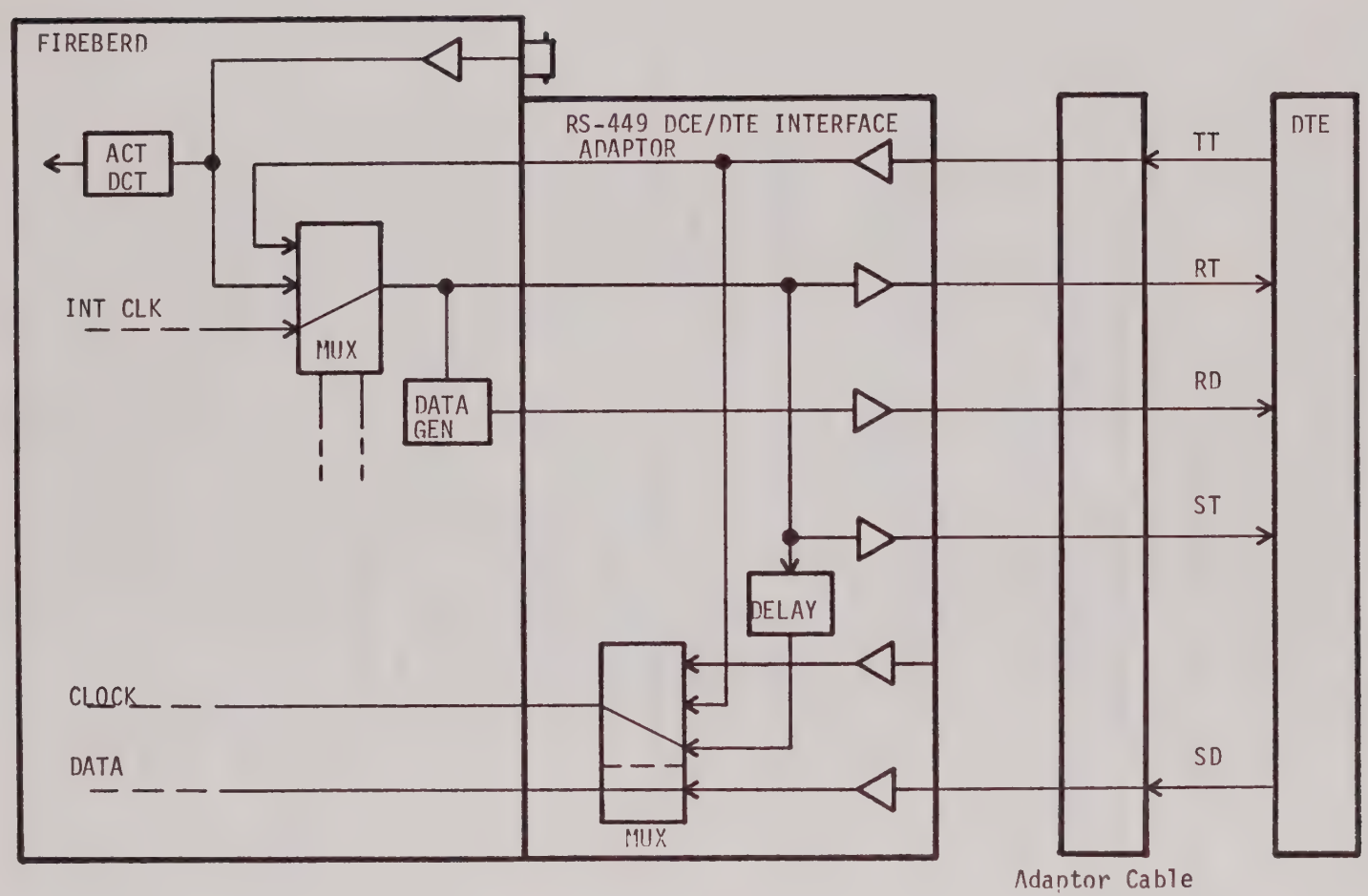


FIGURE 7-6 DCE-ST
INTERFACE: "DCE (ST)" POSITION
FIREBERD: "2.4, 4.8,..., F_C, F_D"

Timing for the loop test can be internally generated or, in the EXT position, be received on the TT leads or the rear panel BNC connector, respectively. Loop test tests actual drivers and receivers that are used during normal operation.

7.3.4 FIREBERD Test Points - DTE Operation

This section describes the relationship between the signals present at the Interface Adaptor connector and the signals present at the FIREBERD rear panel test points when DTE operation is specified.

RCV DATA/TX DATA: The voltage at this test point is greater than 2.5 volts when the Receive Data (RD) is a Mark and is less than 0.4 volts when RD is a Space.

RCV TIMING/-: When the RCV CLK switch is in the NORMAL position, the voltage at this test point is greater than 2.5 volts when the Receive Timing (RT) signal is in the ON condition and is less than 0.4 volts when RT is in the OFF condition. When the RCV CLK switch is in the INVERT position, the voltage at the test point is greater than 2.5 volts when the RT signal is in the OFF condition and is less than 0.4 volts when the RT signal is in the ON condition.

TX DATA/RCV DATA: The voltage at this test point will be greater than 2.5 volts when the Send Data (SD) signal is a Mark and is less than 0.4 volts when the SD signal is a Space.

SEND TIMING/TERM TIMING: The voltage at this test point will be greater than 2.5 volts when the Send Timing (ST) signal is in the ON condition and will be less than 0.4 volts when the ST signal is in the OFF condition. Use of the TX CLK NORMAL/INVERT switch will not affect these relationships.

TERM TIMING/RCV TIMING: This test point will be greater than 2.5 volts when the Terminal Timing (TT) signal is in the ON condition and will be less than 0.4 volts when TT is in the OFF condition.

7.3.5 FIREBERD Test Points - DCE Operation

This section describes the relationship between the signals present at the Interface Adaptor connector and the signals present at the FIREBERD rear panel test points when DCE operation is specified.

RCV DATA/TX DATA: The voltage at this test point will be greater than 2.5 volts when the Send Data (SD) signal is a Mark and will be less than 0.4 volts when the SD signal is a Space.

RCV TIMING/-: No signal will be present at this test point.

TX DATA/RCV DATA: The voltage at this test point will be greater than 2.5 volts when the Receive Data (RD) signal is a Mark and will be less than 0.4 volts when the RD signal is a Space.

SEND TIMING/TERM TIMIMG: The voltage at this test point will be greater than 2.5 volts when the Terminal Timing (TT) signal is in the ON position and will be less than 0.4 volts when TT is in the OFF position.

Use of either CLK NORMAL/INVERT switch will not affect this relationship.

TERM TIMING/RCV TIMING: The voltage at this test point will be greater than 2.5 volts when the Receive Timing (RT) signal is in the ON condition and will be less than 0.4 volts when RT is in the OFF condition. Use of either CLK NORMAL/INVERT switch will not affect this relationship.

7.3.6 Specifications

RS-449 Category 1 Circuits (RS-423/RS422 TERM/RS-422 UNTERM):

Send Data (SD)
Receive Data (RD)
Terminal Timing (TT)
Send Timing (ST)
Receive Timing (RT)
Request to Send (RS)
Clear to Send (CS)
Receiver Ready (RR)
Terminal Ready (TR)
Data Mode (DM)

RS-449 Category 2 Circuits (RS-423 only);

Local Loopback (LL)
Remote Loopback (RL)
Test Mode (TM)

RS-422 Data Mark (binary 1), Control Lead OFF:
Lead (A) more negative than Lead (B)

RS-422 Data Space (binary 0), Control Lead ON:
Lead (A) more positive than Lead (B)

RS-423 Data Mark (binary 1), Control Lead OFF:
Negative polarity

RS-423 Data Space (binary 0), Control Lead ON:
Positive polarity

RS-422 Line Drivers
Output differential voltage: 2.0 volts minimum
Short circuit current: 150 mA maximum
Output rise time: 20 nsec maximum

RS-423 Line Drivers

Output voltage: ± 3.5 volts minimum
Short circuit current: 150 mA maximum
Output rise time: 1 microsecond typical (Model 40200-01)
4 microsecond typical (Model 40200-02)

RS-422 Terminated Line Recivers:

Load impedance: 100 ohms ± 10%
Differential input threshold voltage: ± 0.25 volts

RS-422 Unterminated Line Receivers

Load impedance: 2000 ohms minimum
Differential input threshold voltage: ± 0.25 volts

RS-423 Receivers:

Load impedance: 2000 ohms minimum
Input threshold voltage: ± 0.25 volts

Table 7-2. RS-449 DTE/DCE INTERFACE ADAPTOR CONNECTOR PIN ASSIGNMENTS

PIN	CIRCUIT	449 DESCRIPTION	COMMENT
1	SHIELD	Ground	internally connected to 20, 37, 19
2	SI	Signaling Rate Indicator	open
3	SPARE	Spare	ST (DCE only)
4	SD (A)	Send Data	output
5	ST (A)	Send Timing	input
6	RS (A)	Receive Data	input
7	RS (A)	Request to Send	output
8	RT (A)	Receive Timing	input
9	CS (A)	Clear to Send	input
10	LL	Local Loopback	423 output
11	DM (A)	Data Mode	input
12	TR (A)	Terminal Ready	output
13	RR (A)	Receiver Ready	input
14	RL	Remote Loopback	423 output
15	IC	Incoming Call	open
16	SF/SR	Select Frequency/ Signaling Rate Selector	open
17	TT (A)	Terminal Timing	output
18	TM	Test Mode	input
19	SG	Signal Ground	
20	RC	Receive Common	
21	SPARE	Spare	ST (DCE only)

Table 7-2. RS-449 DTE/DCE INTERFACE ADAPTOR (Cont.)
CONNECTOR PIN ASSIGNMENTS

PIN	CIRCUIT	449 DESCRIPTION	COMMENT
22	SD (B)	Send Data	output
23	ST (B)	Send Timing	input
24	RB (B)	Receive Data	input
25	RS (B)	Request to Send	output
26	RT (B)	Receive Timing	input
27	CS (B)	Clear to Send	input
28	IS	Terminal in Service	open
29	DM (B)	Data Mode	input
30	TR (B)	Terminal Ready	output
31	RR (B)	Receiver Ready	input
32	SS	Select Standby	open
33	SQ	Signal Quality	open
34	NS	New Signal	open
35	TT (B)	Terminal Timing	output
36	SB	Standby Indicator	open
37	SC	Send Common	

7.4 RS-449 BRIDGING INTERFACE ADAPTOR (MODEL #40198)

7.4.1 Introduction

The RS-449 Bridging Interface is an unterminated "Receive Only" interface designed to bridge across standard RS-449 circuits. This interface may be used to employ just the receive section of the FIREBERD or to "bridge across" an operating RS-449 circuit with an adaptor cable (optional). The circuit on which the bridging interface will be used can conform to either RS-422 (Balanced) or RS-423 (Unbalanced) specifications. The RS-449 Bridging Interface can be used with any of the standard test patterns generated by a FIREBERD or similar device.

7.4.2 Functional Description

The RS-449 Bridging Interface is designed to translate the RS-422 or RS-423 signals into TTL signals to be processed by the FIREBERD. A three position toggle switch on the interface panel selects the clock and data source for the FIREBERD receive section. In the SD & ST position the SEND DATA (DTE Source) and Send Timing (DCE Source) are selected for BER measurement. In the SD & TT position, Send Data & Terminal Timing (both DTE Source) are selected for BER measurement. In the RD & RT position Received Data and Receive Timing (both DCE Source) are selected for BER measurement.

A two position toggle switch on the interface panel allows the operator to invert the clock on the lead pairs selected to be monitored. In the INVERT position, FIREBERD will expect the selected data source to be valid on the rising edge of the selected clock source instead of the falling edge (Normal). In the INVERT position, a NON-STANDARD TIMING indicator becomes illuminated warning the operator of a non-standard Clock/Data phase relationship.

A two-position toggle switch on the interface panel tells the FIREBERD to display either the DTE or DCE generated signaling. With the switch in the DTE position, TR (Terminal Ready), RS (Request to Send), LL (Local Loopback), and RL (Remote Loopback) are selected to be displayed. With the switch in the DCE position, DM (Data Mode), RR (Receiver Ready), CS (Clear to Send), and TM (Test Mode) are selected to be displayed. Note that when this switch is in the DTE position the FIREBERD front panel DCE LED will illuminate to indicate the appropriate signal names. With the switch in the DCE position, the DTE LED will illuminate.

If the inputs to any of the receivers in this Interface Module are left open, the corresponding receiver output may assume the ON or OFF condition, or may toggle back and forth between the ON and OFF states.

7.4.3 Test Points

The RS-449 Bridging Interface utilizes only the receive section of the FIREBERD. The RS-449 Bridging Interface has no transmit functions (with the exception of Loop Test - see Section 7.4.4). The selected Clock and Data source will appear at the DTE RT (Receive Timing) and RD (Receive Data) test points only. With proper use of the CLK INVERT switch, the data will be falling edge valid at the FIREBERD test points.

7.4.4 Loop Test

Loop testing of the interface is done at TTL levels. Connections to the interface do not have to be removed to do a loop test, however, the front panel clock select switch must be set to one of the internal rates to provide timing for the loop test. Only the rear panel BNC can provide timing for the loop test with the GENERATOR CLOCK switch set to the "EXT" position.

7.4.5 Specifications

Unterminated Receivers
(Clock, Data and Signaling):

Load Impedance: greater than 4 K ohms
Input Threshold: ± .2 volts

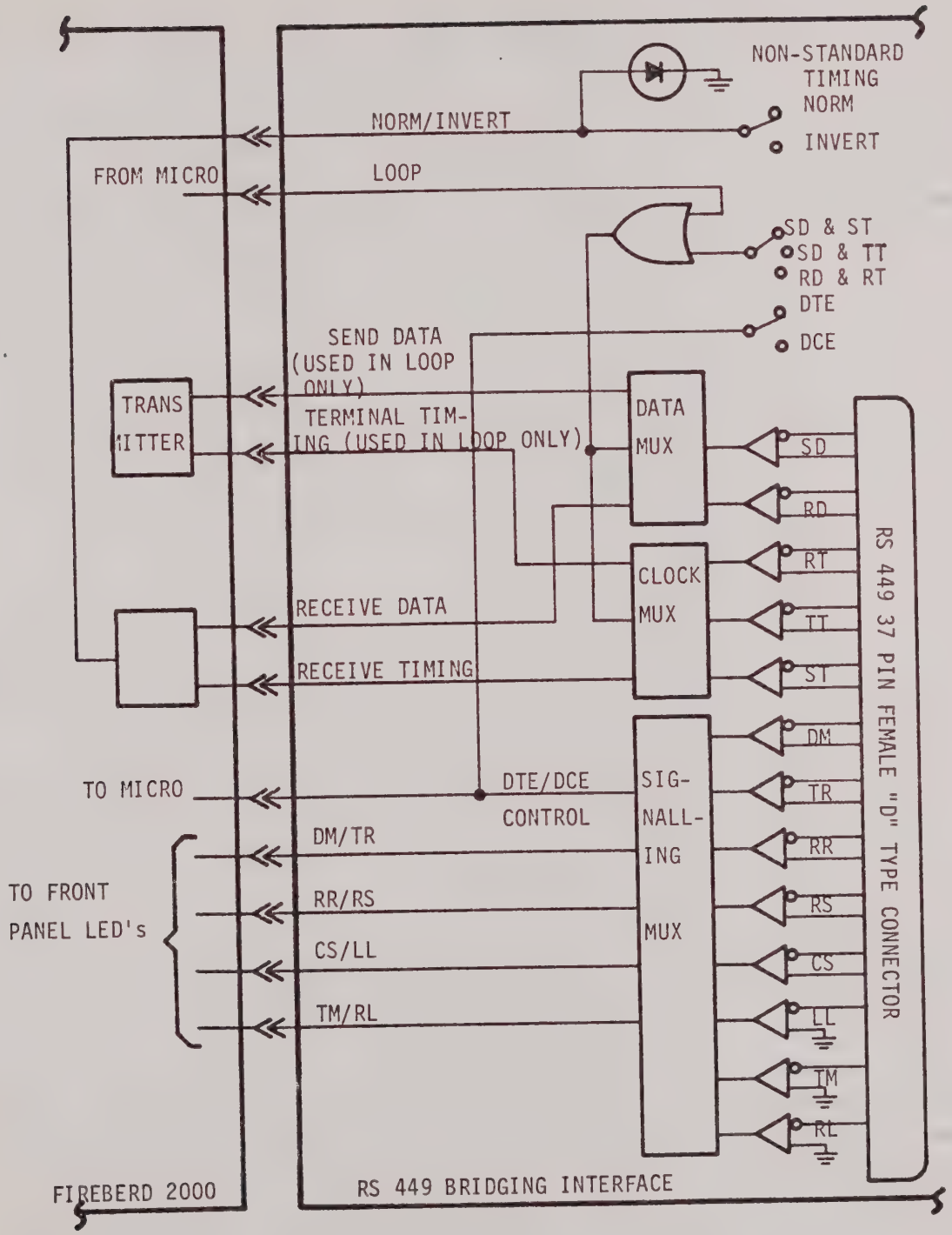


FIGURE 7-7. RS-449 BRIDGING INTERFACE - FUNCTIONAL BLOCK DIAGRAM

TABLE 7-3

RS-449 CONNECTOR PIN ASSIGNMENTS

PIN	CIRCUIT	449 DESCRIPTION	COMMENT
1	SHIELD	Ground	internally connected to 20, 37, 19, 30
2	SI	Signaling Rate Indicator	open
3	SPARE	Spare	open
4	SD (A)	Send Data	input
5	ST (A)	Send Timing	input
6	RD (A)	Receive Data	input
7	RS (A)	Request to Send	input
8	RT (A)	Receive Timing	input
9	CS (A)	Clear to Send	input
10	LL	Local Loopback	input
11	DM (A)	Data Mode	input
12	TR (A)	Terminal Ready	input
13	RR (A)	Receiver Ready	input
14	RL	Remote Loopback	input
15	IC	Incoming Call	open
16	SF/SR+	Select Frequency/ Signaling Rate Selector	open
17	TT (A)	Terminal Timing	input
18	TM	Test Mode	input
19	SG	Signal Ground	
20	RC	Receive Common	
21	SPARE	Spare	open

TABLE 7-3 (Cont.)

RS-449 CONNECTOR PIN ASSIGNMENTS

PIN	CIRCUIT	449 DESCRIPTION	COMMENT
22	SD (B)	Send Data	input
23	ST (B)	Send Timing	input
24	RD (B)	Receive Data	input
25	RS (B)	Request to Send	input
26	RT (B)	Receive Timing	input
27	CS (B)	Clear to Send	input
28	IS	Terminal in Service	open
29	DM (B)	Data Mode	input
30	TR (B)	Terminal Ready	input
31	RR (B)	Receiver Ready	input
32	SS	Select Standby	open
33	SQ	Signal Quality	open
34	NS	New Signal	open
35	TT (B)	Terminal Timing	input
36	SB	Standby Indicator	open
37	SC	Send Common	

7.5 V.35/306 DTE INTERFACE ADAPTOR MODULE (MODEL 40138)

7.5.1 Introduction

The V.35/306 INTERFACE ADAPTOR MODULE is designed to meet the following interface specifications:

1. CCITT Recommendation V.35

2. 306 Type Wideband Data Set. Bell System Technical Reference Publication 41304.

3. Digital Data System Data Service Unit. Bell System Technical Reference Publication 41450.

This interface enables a FIREBERD to act as Data Terminal Equipment (DTE) for use in testing Data Communications Equipment (DCE). The data is exchanged in serial binary format with a synchronous clock. The following sections provide functional, switch, test point, and specificaton descriptions.

7.5.2 Functional Description

The V.35/306 Interface Adaptor converts between the signal characteristics specified by the appropriate interface specifications and the TTL signals used by FIREBERD.

When the unit is used in a 306 type system, the DCE supplies timing to the FIREBERD on the SCT lead. This signal is selected by the EXT position of the GENERATOR CLOCK switch on the FIREBERD front panel. The selected clock is used to generate Send Data (SD) and Serial Clock Transmit External (SCTE), which are sent back to the DCE. Alternatively, SD and SCTE may be generated from timing supplied through the rear panel BNC input or one of the internal rates.

When the unit is used in a V.35 or Data Service Unit (DSU) System, timing is supplied to the FIREBERD in the same manner as 306 type systems. However, V.35 and DSU systems do not accept the SCTE signal from the FIREBERD. The maximum operating speed is limited in this operating mode due to the cable delay and the 70 ns delay between the incoming SCT signal and the out-going SD signal.

Two high speed balanced V.35 drivers are provided for the Send Data and SCTE outputs. Two other drivers, Request to Send (RTS) and Data Terminal Ready (DTR) are designed according to RS-232C and CCITT V.28 specifications. The RTS output is controlled by a FIREBERD front panel switch. The DTR (CD) output is tied high on Rev A* and Rev B Interface Modules. The DTR output on Rev C and higher Interface Modules is controllable from the FIREBERD front panel TR(DTR)/DM(DSR) switch. There are three high speed balanced V.35 type receivers provided for the Serial Clock Transmit (SCT), Receive Data (RD), and the Serial Clock Receive (SCR). The SCT signal is sent to the transmit section of FIREBERD where it may be selected for use by the GENERATOR CLOCK switch. Receive Data (RD) and the Serial Clock Receive (SCR) signals are sent to the receiver section of FIREBERD for error analysis. Three other receivers, Data Set Ready (DSR), Clear to Send (CTS), and Receive Line Signal Detector (RLSD) directly drive the FIREBERD front panel LEDs. These receivers are designed according to the RS-232C and CCITT V.28 specifications.

Also included in the interface adaptor is a loop test relay designed to connect the transmit clock and data outputs to the receive clock and data inputs when the FIREBERD LOOP TEST switch is in the LOOP position. This relay will also disconnect the drivers and receivers from the interface connector. Loop Test does not affect the TX TIMING IN (SCT) signal.

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*The Interface Module revision level is visible on the bottom of the printed circuit board near the model number (40138 Rev X).

7.5.3 Data-Clock Test Points

This section describes the relationship between the data and clock signals at the interface connector and the FIREBERD test points when the V.35/306 Interface Adaptor is in use.

RCV DATA/RX DATA

The signal at this test point is greater than 2.5 volts when the received data at the RD input of the Interface Adaptor is a differential voltage with the B input being more positive than the A input (Mark). The RCV DATA Test Point is less than .4 volts when the received data at RD is a differential voltage such that the A input is more positive than the B input (space).

RCV TIMING/-

This test point provides a TTL signal, equivalent to the received clock (SCR) at the input to the V.35/306 INTERFACE ADAPTOR. With the RCV CLK polarity switch in the normal position, the signal at this test point is greater than 2.5 volts when the received clock signal at the SCR input to the Interface Adaptor is a differential voltage such that the A input is greater than the B input. A voltage of less than .4 volts at this test point is present when the A input is less positive than the B. With the RCV CLK (SCR) switch in the INVERT position the signal at this test point will be inverted to that signal at the Interface Adaptor input.

TX DATA/RCV DATA

This test point provides the TTL equivalent of the signal at the Send Data (SD) output of the Interface Adaptor. The signal at this test point is greater than 2.5 volts when the differential voltage at the Send Data outputs are such that the B output is more positive than the A output (Mark). The test point signal is less than .4 volts when the differential voltage at the Send Data output consists of the A output being more positive than the B output (Space).

SEND TIMING/TERM TIMING

This test point provides a TTL signal equivalent to the signal at the Serial Clock Transmit (SCT) inputs at the Interface Adaptor. The signal at this test point is greater than 2.5 volts when the A input at the Interface is more positive than the B input. The test point signal is less than .4 volts when the B input is more positive than the A input.

TERM TIMING/RCV TIMING

The signal at this test point is the TTL equivalent of the signal at the Serial Clock Transmit External (SCTE) output of the Interface Adaptor. The signal at the test point is greater than 2.5 volts when the differential voltage at SCTE is such that the A output is more positive than the B output. The test point is less than .4 volts when the B output is more positive than the A output.

CLOCK-DATA PHASE RELATIONSHIP

With the Clock Invert switches in the NORMAL position the receive clock-data phase relationship at the receive clock and data test points will be the same as that at SCR and RD inputs to the V.35/306 Interface Adaptor. The transmit clock and data test points will have the same phase relationship as the SCTE, SCT, and SD outputs at the Interface Adaptor, independent of the TX CLK POLARITY switch.

With the RCV CLK (SCR) switch in the INVERT position the clock-data phase relationship at the receive clock and data test points will be inverted to that input at the Interface Adaptor.

7.5.4 Switch and Indicator Description

RCV CLK (SCR)

The RCV CLK (SCR) switch controls the polarity of the received clock signal (SCR) as it enters the FIREBERD from the V.35/306 Interface Adaptor. In the NORM position, the data (RD) - clock (SCR) phasing is accepted according to the interface specifications. The INVERT position allows FIREBERD to accept data and clock phasing inverted with respect to the interface specifications.

TX CLK SCTE AND SCT

The TX CLK SCTE and SCT switch controls the polarity of the clock used to develop the transmit clock and data functions inside the FIREBERD. The NORM position transmits the data-clock phasing at the interface as stated in the interface specifications. In the INVERT position, the transmit clock is phase inverted with respect to the specifications.

NON STANDARD TIMING

This indicator will illuminate when either or both clock invert switches are in the INVERT position.

7.5.5 Specifications

General:	Maximum speed: (Normally functions to 10 MHz)
	Delay SCT to SD: approximately 70 ns
	Skew SCTE to SD: approximately 15 ns
Balanced Drivers:	Signal swing (Bipolar):
	$\pm$ .55v $\pm$ .1 into 100 ohms

TABLE 7-4

V.35/306 CONNECTOR PIN ASSIGNMENTS

PIN	CIRCUIT	V.35/306 DESCRIPTION	COMMENT
A	AA	Protective Ground	internally connected to B
B	AB	Signal Ground	internally connected to A
C	CA	Request to Send	output
D	CB	Clear to Send	input
E	CC	Data Set Ready	input
F	CF	Received Line Signal Detector	input
H	CD	Data Terminal Ready	output
J	CE	Ring Indicator	open
K	—	Local Test	open
R	RD (A)	Received Data	input
T	RD (B)	Received Data	input
V	SCR (A)	Serial Clock Receive	input
X	SCR (B)	Serial Clock Receive	input
P	SC (A)	Send Data	output
S	SC (B)	Send Data	output
U	SCTE (A)	Serial Clock Transmit External	output
W	SCTE (B)	Serial Clock Transmit External	output
Y	SCT (A)	Serial Clock Transmit	input
AA or a	SCT (B)	Serial Clock Transmit	input

Balanced Drivers (Cont.)	Short circuit current: less than 100 mA Rise Time: less than 20 ns Generator Impedance: less than 100 ohms
Balanced Receivers:	Load resistance: 100 ohms
Unbalanced Drivers(RS-232)	Rise time: greater than 20 microseconds Generator Impedance: less than 100 ohms Short circuit current: less than 100 mA
Unbalanced Receivers(RS-232)	Load Impedance: 3K to 7K ohms Maximum input voltage: ± 25v

7.6 V.35/306 DTE/DCE INTERFACE ADAPTOR MODULE (MODEL #40202)

7.6.1 Introduction

The V.35/306 DTE/DCE Interface Adaptor Module is designed in accordance with the following interface specifications:

* CCITT Recommendation V.35

* 306 Type Wideband Data Set. Bell System technical reference: Publications 41304

* Digital Data System Data Service Unit. Bell System Techincal Reference Publications 41450.

This interface enables a FIREBERD to act as a Data Terminal Equipment (DTE) for use in testing Data Communications Equipment (DCE). With the use of a special adaptor cable (included) the FIREBERD can be configured as Data Communications Equipment (DCE) for testing Data Terminal Equipment (DTE). The data is exchanged in serial binary format with a synchronous clock. The following sections provide specifications and functional descriptions.

7.6.2 Functional Description - DTE Operation

The V.35/306 DTE/DCE Interface Adaptor converts the signal characteristics specified by the appropriate interface specifications to the TTL signals used by the FIREBERD.

In a 306 Type system, the DCE supplies timing to the DTE (FIREBERD) on the SCT (Serial Clock Transmit) leads. With FIREBERD's GENERATOR CLOCK switch in the EXT position, FIREBERD will generate SD (SEND DATA) and SCTE (Serial Clock Transmit External) coincident with the clock received on the SCT leads.

With FIREBERD's GENERATOR CLOCK switch set to any of the internal rates (including FA, FB, FC, or FD if so equipped), the FIREBERD will ignore the SCT leads and generate SD and SCTE coincident with the selected internal rate.

In a V.35 or Data Service Unit (DSU) type system, timing is supplied to the FIREBERD on the SCT leads in the same manner as the 306 type system. However, the V.35 and DSU type systems do not accept the SCTE signal from the FIREBERD. With the FIREBERD interface set for V.35 operation, the SCTE driver is disabled and the GENERATOR CLOCK switch should be set to the EXT position. (With an internal clock chosen, data only will appear at the interface connector). In both the V.35 and 306 modes, data and clock are received for BER measurement on the RD (Receive Data) and the SCR (Serial Clock Receive) leads, respectively.

Two clock switches are provided on the V.35/306 DTE/DCE Interface panel. As a DTE, setting the TRANSMIT CLOCK INVERT switch to the INVERT position causes SD (Send Data) to be valid on the rising edge of the chosen clock source instead of the falling edge (Normal). Setting the RECEIVE CLOCK INVERT switch to the INVERT position causes the FIREBERD to expect valid data (RD) on the rising edge of the SCR Clock instead of the falling edge (Normal). If either of the clock invert switches are set to the INVERT position, a NON-STANDARD TIMING LED becomes illuminated.

All clock and data drivers and receivers are high speed balanced V.35 type. All signaling drivers and receivers are single-ended RS-232 (CCITT V.28) type. RS (Request to Send) and DTR (Data Terminal Ready) are controlled by a FIREBERD front panel switches. DSR (Data Set Ready), RLSD (Receive Line Signal Detect) and CS (Clear to Send) are received and their status displayed on the front panel of the FIREBERD.

A LOOP TEST switch is provided on the front panel of the FIREBERD which will, in the LOOP position, connect the transmit clock and data outputs to the receive clock and data inputs. User connections do not have to be removed during a loop test. External timing for the loop test can be provided

on the SCT leads (DCE Source) or through the rear panel BNC Connector. Loop test tests actual drivers and receivers that are used during normal operation.

7.6.3 Functional Description - DCE Operation

The V.35/306 DTE/DCE Interface Adaptor can easily be configured to look like a DCE (Data Communications Equipment) for testing of DTE (Data Terminal Equipment) by using a special adaptor cable (included). When the special adaptor cable is connected to the interface, configuration as a DCE is done automatically. (A spare grounded pin in the interface cable tells the FIREBERD it is being used as a DCE.)

In a 306 Type system, the DCE (FIREBERD) supplies timing to the DTE on the SCT (Serial Clock Transmit) leads. The DTE will return to the DCE (FIREBERD), SD (Send Data), and SCTE (Serial Clock Transmit External) which may or may not be coincident with the clock on the SCT leads (Depending upon the configuration of the DTE.) The SD and SCTE signals are then translated to TTL and sent to the receive section of FIREBERD for BER measurement.

In a V.35 or Data Service Unit (DSU) type system, SCT (Serial Clock Transmit) is generated in the DCE (FIREBERD) as in the 306 type system. However, the DTE will not return timing on the SCTE (Serial Clock Transmit External) leads. The DTE returns only SD (Send Data) to the DCE (FIREBERD) coincident with the DCE-generated SCT. In the V.35 mode as a DCE, the SCTE receiver is disabled.

In both the V.35 and 306 modes, the FIREBERD as a DCE generates SCR (Serial Clock Receive) and RD (Receive Data) and sends them to the DTE.

All clock and data drivers and receivers are high speed balanced V.35 type. All signaling drivers and receivers are single-ended RS-232 (CCITT V.28) type. Two toggle switches on the front panel of the FIREBERD allow RLSD (Receive Line Signal Detect) and DSR (Data Set Ready) signal to be turned on

and off in the DCE mode. DTR (Data Terminal Ready), RS (Request to Send), and LT (Local Test) are received and their status displayed on the FIREBERD front panel. The DTE generated RS (Request to Send) is tied directly back to the DTE received CS (Clear to Send).

Two clock invert switches are provided on V.35/306 DTE/DCE interface panels. As a DCE, setting the RECEIVE CLOCK INVERT switch to the INV position causes FIREBERD to generate a valid RD (Receive Data) on the rising edge of SCR (Serial Clock Receive). Setting the TRANSMIT CLOCK INVERT switch to the INV position causes FIREBERD to expect valid SD (Send Data) on the rising edge of the SCTE (Serial Clock Transmit External) for 306 Mode or SCT (Serial Clock Transmit) if the V.35 mode is chosen. If either of the clock invert switches are set to the INV position, a NON-STANDARD TIMING LED becomes illuminated.

When the LOOP TEST switch on the front panel of the FIREBERD is in the LOOP position, this interface, using relays, connect the transmit clock and data outputs to the receive clock and data inputs. User connections do not have to be removed to perform a loop test. External timing can be provided for the loop test on the SCTE leads (306 mode only) or through the rear panel BNC connector. Loop test tests the actual drivers and receivers that are used during normal operation.

7.6.4 Data/Clock Test Points - DTE Operation

This section describes the relationship between the signals at the interface connector and the signals at the FIREBERD rear panel test points when the FIREBERD is used as a DTE.

RCV DATA/TX DATA

The signal at this test point will be greater than 2.5 volts when the data at the Receive Data (RD) leads is a Mark and will be less than 0.4 volts when RD is a Space.

RCV TIMING/-

With the RCV CLK POLARITY switch in the NORMAL position, the signal at this test point will be greater than 2.5 volts when the (A) input of the SCR signal is more positive than the (B) input (ON). The signal at the test point will be less than 0.4 volts when the (A) input is more negative than the (B) input (OFF). Placing the RCV CLK POLARITY switch in the INVERT position inverts the test point/interface connector phase relationship.

TX DATA/RCV DATA

The signal at this test point will be greater than 2.5 volts when the data at the Send Data (SD) leads is a Mark and will be less than 0.4 volts when SD is a Space.

SEND TIMING/TERM TIMING

The signal at this test point will be greater than 2.5 volts when the (A) input of the SCT signal is more positive than the (B) input (ON). The test point will be less than 0.4 volts when the (A) input of SCT is more negative than the (B) input (OFF). Use of the TX CLK POLARITY switch will not affect this relationship.

7.6.5 Data/Clock Test Points - DCE Operation

This section describes the relationship between the signals at the interface connector and the signals at the FIREBERD rear panel test points when the FIREBERD is used as a DCE.

RCV DATA/TX DATA

The signal at this test point will be greater than 2.5 volts when the Send Data (SD) signal is a Mark and will be less than 0.4 volts when SD is a Space.

TX DATA/RCV DATA

The signal at this test point will be greater than 2.5 volts when the Receive Data (RD) signal is a Mark and will be less than 0.4 volts when RD is a Space.

SEND TIMING/TERM TIMING

The signal at this test point will be greater than 2.5 volts when the (A) lead of the SCTE signal is more positive than the (B) lead. Use of the TX CLK POLARITY switch will not affect this relationship.

TERM TIMING/RCV TIMING

The signal at this test point will be greater than 2.5 volts when the (A) lead of the SCR signal is more positive than the (B) lead. The test point will be less than 0.4 volts when the (A) lead of SCR is more negative than the (B) lead. Use of the RCV CLK POLARITY switch will not affect this relationship.

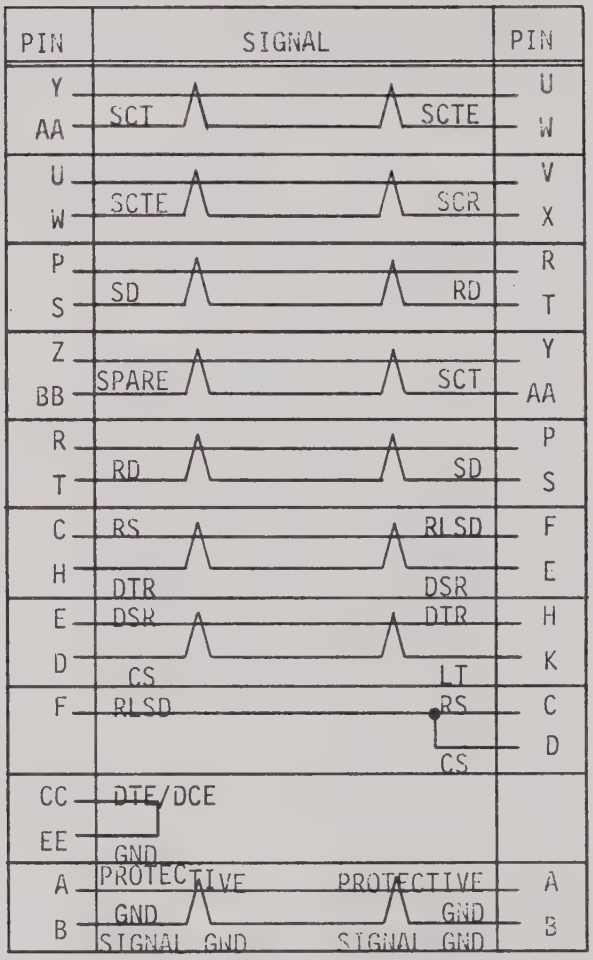
7.6.6 Specifications

General:	Maximum speed (306 mode): 10 MHz Maximum speed (V.35 mode): Cable length dependent Delay SCT to SD: approximately 70 ns typical Skew SCTE to SD: approximately 20 ns typical
Balanced Drivers:	Signal swing (Bipolar): $\pm$ .55 V $\pm$ .1 into 100 ohms Short circuit current: less than 100 mA

Balanced Drivers (Cont.)	Rise Time: less than 20 ns Generator Impedance: 100 ohms
Balanced Receivers:	Load resistance: 100 ohms
Unbalanced Drivers(RS-232C):	Rise time: greater than 20 microseconds Generator Impedance: less than 100 ohms Short circuit current: less than 100 mA Output level (7K Load): ± 10v typical
Unbalanced Receivers:	Load Impedance: 3K to 7K ohms Maximum input voltage: ± 25v

FIGURE 7-8 V.35/306 DTE TO DCE ADAPTOR CABLE
FIREBERD

MALE CONNECTOR
FIREBERD



FEMALE CONNECTOR
TO DTE

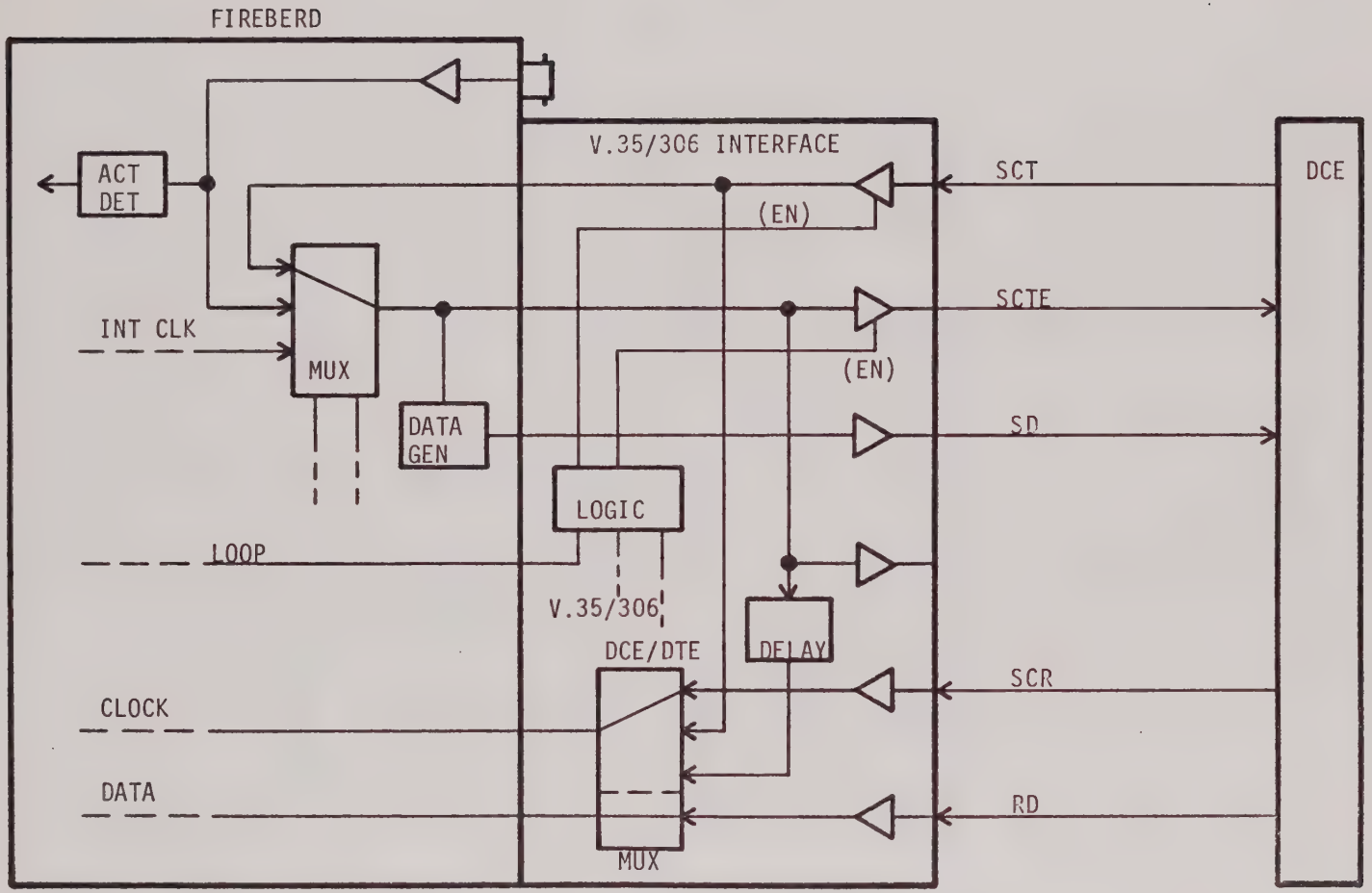


FIGURE 7-9 306 DTE

INTERFACE: "306" POSITION
FIREBERD: "EXT" POSITION

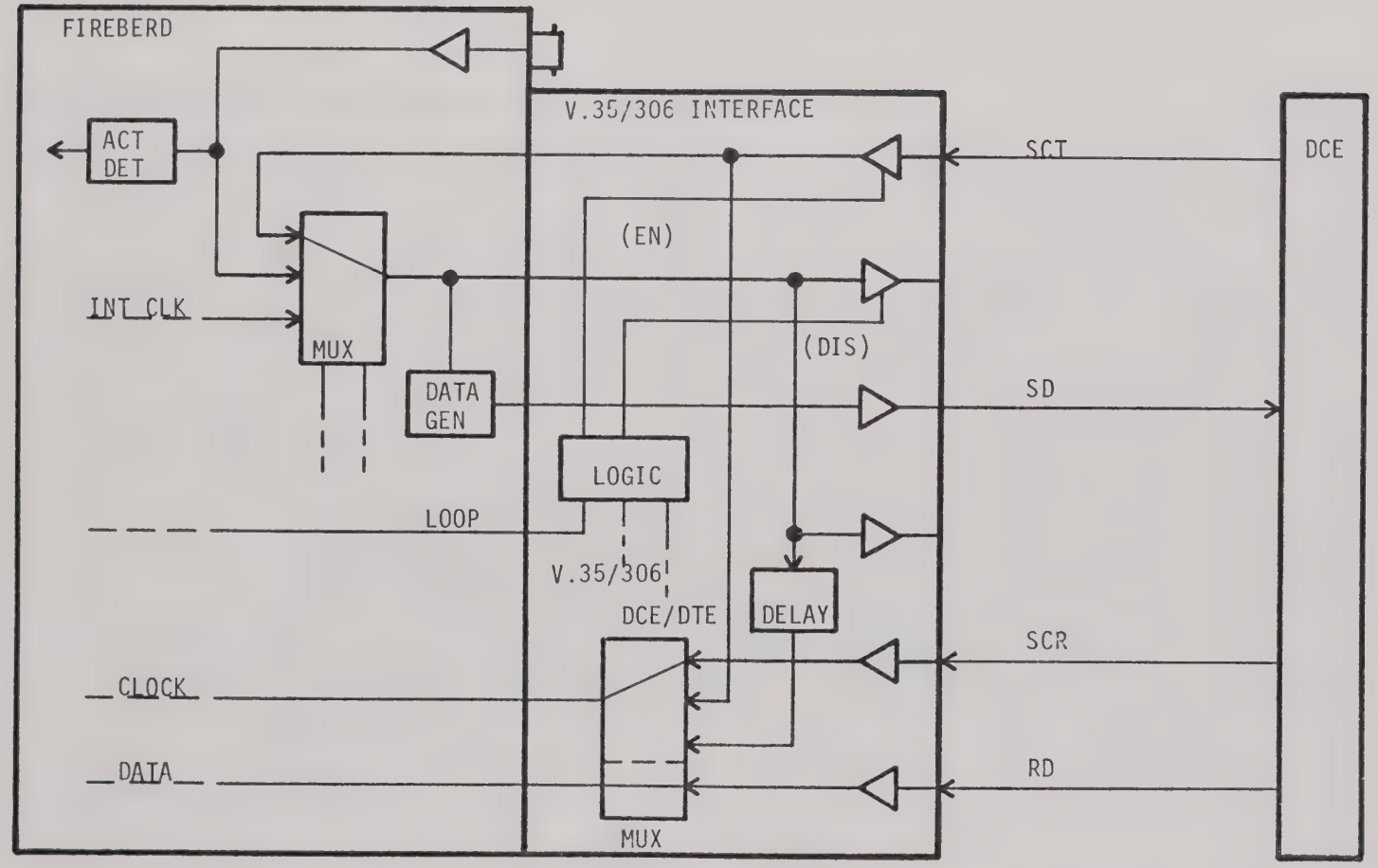


FIGURE 7-10 V.35 DTE

INTERFACE: "V.35" POSITION
FIREBERD: "EXT" POSITION

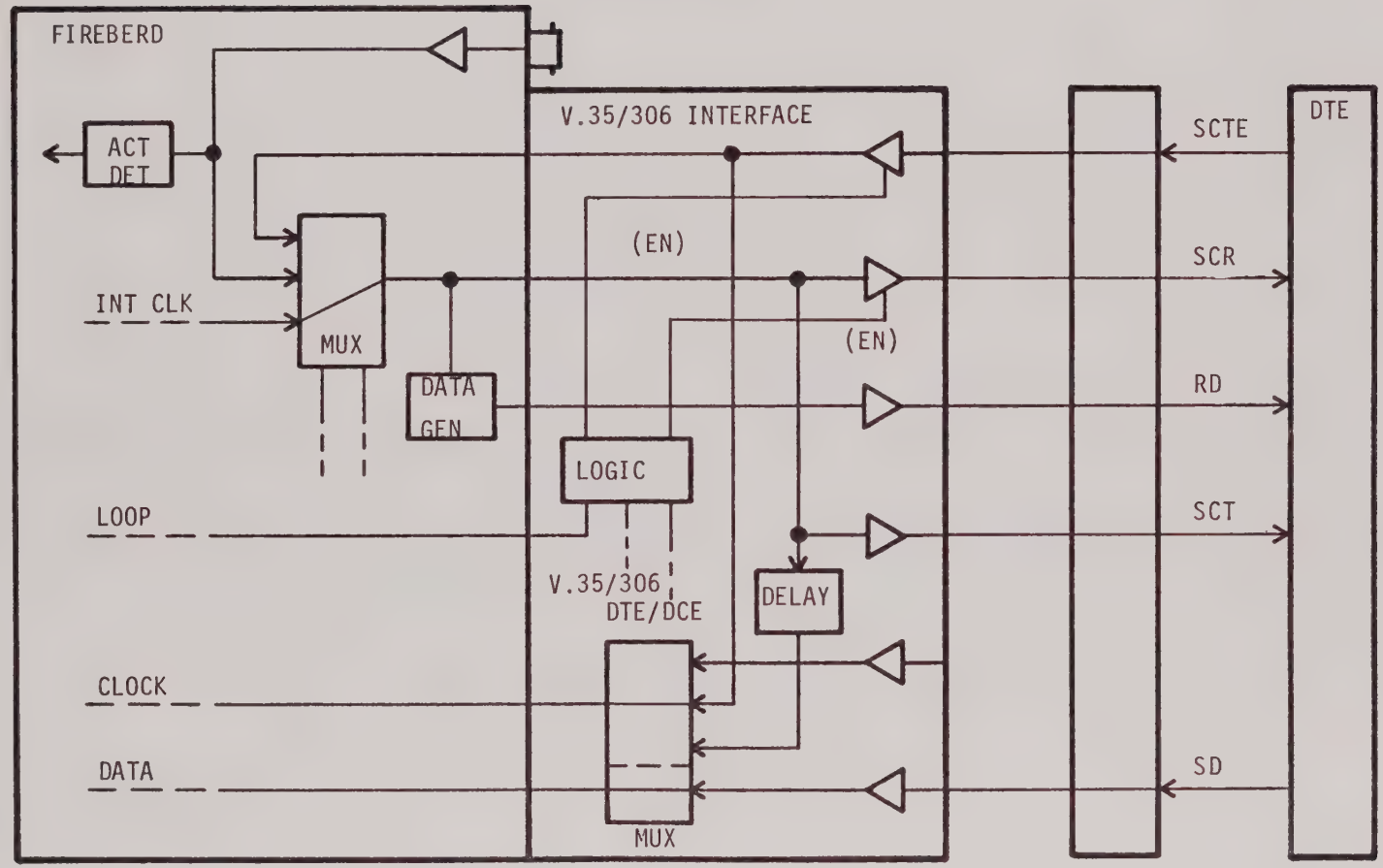


FIGURE 7-11 306 DCE

INTERFACE: "306" POSITION
FIREBERD: "2.4, 4.8,..., F_C, F_D"

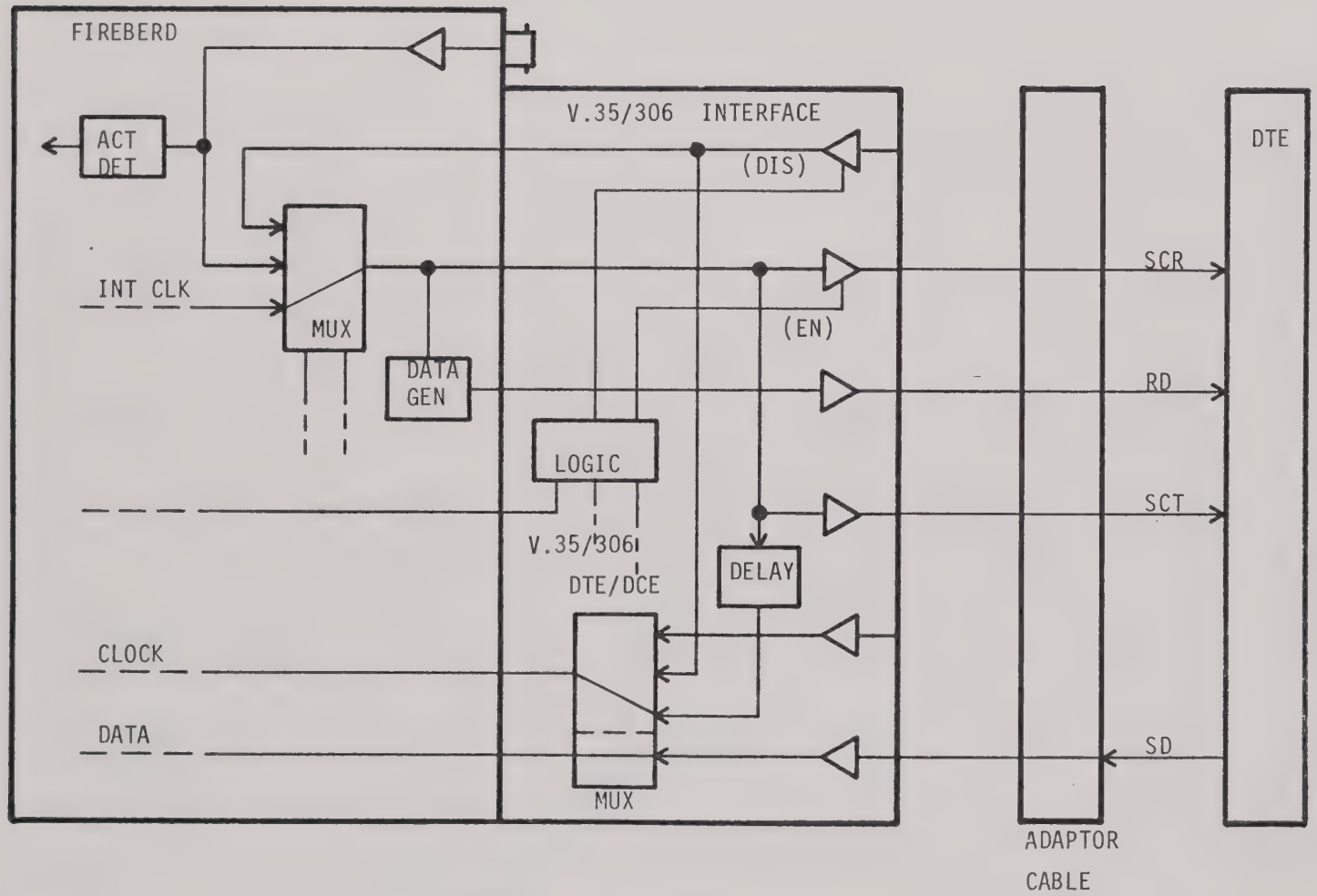


FIGURE 7-12 V.35 DCE

INTERFACE: "V.35" POSITION
FIREBERD: "2.4, 4.8,..., F_C, F_D"

TABLE 7-5

V.35/306 DTE/DCE CONNECTOR PIN ASSIGNMENTS

PIN	CIRCUIT	V.35/306 DESCRIPTION	COMMENT*
A	AA	Protective Ground	internally connected to B
B	AB	Signal Ground	internally connected to A
C	CA	Request to Send	output
D	CB	Clear to Send	input
E	CC	Data Set Ready	input
F	CF	Received Line Signal Detector	input
H	CD	Data Terminal Ready	output
J	CE	Ring Indicator	open
K	--	Local Test	open
R	RD (A)	Received Data	input
T	RD (B)	Received Data	input
V	SCR (A)	Serial Clock Receive	input
X	SCR (B)	Serial Clock Receive	input
P	SD (A)	Send Data	output
S	SD (B)	Send Data	output
U	SCTE (A)	Serial Clock Transmit External	output
W	SCTE (B)	Serial Clock Transmit External	output
Y	SCT (A)	Serial Clock Transmit	input

*Comments refer to Interface Panel Connector and are applicable for DTE operation only.

TABLE 7-5 (CONTINUED)

V.35/306 CONNECTOR PIN ASSIGNMENTS

PIN	CIRCUIT	V.35/306 DESCRIPTION	COMMENT*
AA or a	SCT (B)	Serial Clock Transmit	input
BB	SCT (A) (DCE mode only)	Spare	output (disabled in DTE mode)
Z	SCT (B) (DCE mode only)	Spare	output (disabled in DTE mode)
EE	GND	Spare	internally connected to B
CC	DTE/DCE	Spare	connected to B in DCE mode

*Comments refer to Interface Panel Connector and are applicable for DTE operation only.

TABLE 7-6

CROSS REFERENCE FOR CONNECTOR PIN LETTERING

MIL. SPEC. C-22857-C Connector	Commercial Connector
A	A
B	B
C	C
D	D
E	E
F	F
H	H
J	J
K	K
L	L
M	M
N	N
P	P
R	R
S	S
T	T
U	U
V	V
W	W
X	X
Y	Y
Z	Z
AA	a
BB	b
CC	c
DD	d
EE	f
FF	g
HH	h
JJ	i
KK	j
LL	k
MM	m
NN	n

7.7 WECO 303 INTERFACE ADAPTOR MODULE (MODEL 40182)

7.7.1 Introduction

The 303 Interface Adaptor Module meets the interface specifications of the 303 type Wideband Data Stations, Bell System Technial Reference Publications 41302 (1974). This interface adaptor, incorporated with a FIREBERD, is designed to act as Data Terminal Equipment (DTE) for use in testing Data Communications Equipment (DCE). The data is exchanged in a serial binary format with a synchronous clock.

A cable is provided with each 303 Interface Module. This cable provides the connection between the 25 pin type "D" connector on the interface module and the 303 Data Station Connector (See Table 7-7).

The following sections provide a functional, switch, and specification description for the module.

7.7.2 Functional Description

The 303 Interface Adaptor Module converts between the signal levels conforming to the WECO 303 Interface Specification and the TTL signal levels used in the FIREBERD.

This interface provides high-speed current-mode drivers for the Send Data (SD), Serial Clock Transmit External (SCTE), and the Request to Send (RS) outputs. The SD and SCTE signals are transmitted according to the 303 specification. The RS output is controlled by a FIREBERD front panel switch (RTS/RLSD).

TABLE 7-7

CONNECTOR PIN-OUT DESCRIPTION

D-Type Pinouts	Burndy Cable Pinouts	Circuit	Description	Comment
1	E	SD	Send Data	output
2	H	SCTE	Serial Clock Transmit External	output
3	D	RS	Request to Send	output
4				open
5	M	AGC	AGC Center Conductor	input (RLSD LED)
6	J	SCT	Serial Clock Transmit	input
7	C	CS	Clear to Send	input
8				open
9	F	DSR	Data Set Ready	input
10	K	RD	Receive Data	input
11	L	SCR	Serial Clock Receive	input
12				open
13				open
14	ES	(SD)	ground	
15	HS	(SCTE)	ground	
16	DS	(RS)	ground	
17				open
18	MS	DTR	Data Terminal Ready (outer conductor)	output (EIA RS-232)
19	JS	(SCT)	ground	
20	CS	(CS)	ground	
21				open
22				open
23	KS	(RD)	ground	
24	LS	(SCR)	ground	
25				open

There are six high speed current mode receivers, three of which directly drive the FIREBERD front panel DSR, CTS, and RLSD (DTE) LEDS. The other receivers consist of the Serial Clock Transmit (SCT), Receive Data (RD), and the Serial Clock Receive (SCR). The SCT signal is sent to the transmit section of the FIREBERD where it may be selected for use by the GENERATOR CLOCK switch. The SCR and RD signals are sent to the receive section for error analysis. An EIA RS-232 type driver is provided to control the DTR line. Interfaces with serial numbers lower than 033 have the DTR line held in the On condition and Interfaces with serial numbers of 033 or higher allow control of the DTR lead with the FIREBERD front panel DTR switch.

The interface adaptor also includes a loop test relay. When the TEST switch is in the LOOP position on the FIREBERD front panel, this relay connects the SD and SCTE driver outputs to the RD and SCR receiver inputs. It also disconnects the driver and receiver signals from the interface connector.

7.7.3 Switch and Indicator Description

RCV CLK POLARITY

The RCV CLK POLARITY switch controls the polarity of the received clock (SCR) inside the FIREBERD. In the NORMAL position, FIREBERD is prepared to accept data which is falling edge (ON-OFF) valid as specified in the Bell 303 Standard. In the INVERT position, the FIREBERD is prepared to receive data rising edge (OFF-ON) valid due to the inverted received clock.

TX CLK POLARITY

The TX CLK POLARITY switch controls the polarity of the clock used to develop the transmit clock (SCTE) and data functions inside the FIREBERD. The NORMAL position provides data-clock phasing as stated in the Bell 303 specification. The INVERT position provides data-clock phasing inverted to that in the 303 specification.

NON STD TIMING

This indicator will illuminate when either or both clock invert switches are in the INVERT position.

7.7.4 Data-Clock Test Points

This section describes the relationship between the 303 Interface Adaptor data and clock signals and the FIREBERD rear panel test points. The WECO 303 Interface Adaptor is designed to accept a data Mark, signaling OFF as a signal with less than 5 mA. A data Space, signaling ON, is a signal greater than 23 mA.

RCV DATA/TX DATA

The signal at this test point is greater than 2.5 volts when the Received Data (RD) input at the interface adaptor is a signal such that less than 5 mA of current is input to the 100 ohm receiver load (Mark). This test point provides a less than .4 volt signal when the Received Data (RD) input at the Interface adaptor inputs a signal greater than 23 mA (Space).

RCV TIMING/-

When the RCV CLK POLARITY switch is in the NORMAL position, the test point is greater than 2.5 volts when the current at the Serial Clock Receive (SCR) input is greater than 23 mA, and is less than 0.4 volts when the current at the SCR input is less than 5 mA. When the RCV CLK POLARITY switch is in the INVERT position, the test point is 2.5 volts when the current at SCR is less than 5 mA and is 0.4 volts when the current is greater than 23 mA.

TX DATA/RCV DATA

This test point provides a signal of greater than 2.5 volts when the

data at the Send Data (SD) output of the Interface Adaptor is less than 5 mA (Mark) when driving a 100 ohm load. A signal of less than .4 volts is provided at this test point when the SD output is greater than 23 mA (Space) when driving a 100 ohm load.

SEND TIMING/TERM TIMING

This test point provides a 2.5 volt signal when the clock signal at the Serial Clock Transmit (SCT) input is greater than 23 mA. The signal at this point is less than .4 volts when the SCT input receives a signal less than 5 mA. Use of the TX CLK POLARITY switch will not affect this relationship.

TERM TIMING/RCV TIMING

This test point provides a signal of at least 2.5 volts when the Serial Clock Transmit External (SCTE) output at the interface adaptor is less than 5 mA. The signal at this test point is less than .4 volts when the SCTE output is providing a signal greater than 23 mA into a 100 ohm load. Use of the TX CLK POLARITY switch will not affect this relationship.

7.7.5 Specifications

General:	Data Polarity: Data Mark/binary 1, Control Lead OFF, less than 5 mA. Data Space/binary 0, Control Lead ON, greater than 23 mA.
Drivers:	Mark/OFF - less than 4 mA. Space/ON - approximately 35 mA.

Receivers:	Input Impedance: 100 ohms. Open Circuit Voltage: -1 volt. Maximum input voltage: 25 volts. Thresholds: OFF or Mark less than 9.5 mA. ON or Space greater than 10.5 mA.

7.8 DS1 INTERFACE ADAPTOR MODULE (MODEL 40151)

PLEASE NOTE - A newer DS1 type Interface Adaptor Module with additional capability is available - see Section 7.14

7.8.1 Introduction

The DS1 Interface Adaptor Module meets the interface requirements of the Bell System 1.544 Mbps Channel Servie unit specification (Publication 41451) and other systems with DS1 type signals. The DS1 Interface incorporated with the FIREBERD will act as Data Terminal Equipment (DTE) and exchange a serial data signal used in the the testing of Data Communication Equipment (DCE). The data signal is transmitted and received either through the female jacks (TX OUTPUT, RCV INPUT) or the 15 pin "D" type connector on the DS1 Interface Adaptor.

The DS1 Interface Adaptor allows the choice of several timing sources and can be operated in a terminating (110 ohm) or bridging (1000 ohm) mode. The following sections provide a complete functional description of the DS1 Interface Adaptor.

7.8.2 Functional Description

The DS1 Interface Adaptor is designed to convert between the DS1 signals specified by the Bell System Specification and the TTL signals required by the FIREBERD. The DS1 signals are serial, differential return to zero (RZ) with alternate mark inversion (AMI) coding. The transmit data is sent to the TX OUTPUT plug and the TX OUTPUT of the "D" type connector on the DS1 interface panel. Only one of these outputs should be used at any one time.

Timing for the transmit data signal may be developed by selecting either the recovered receive clock signal, an external clock signal input

through the BNC connector on the DS1 interface panel, or the EXT CLK IN input on the FIREBERD Rear Panel. The external (EXT) or recovered clock (RECOV CLK) signal may be selected by the TX TIMING switch on the DS1 interface panel. The TX TIMING is accepted by the FIREBERD when the GENERATOR CLOCK switch is in the EXT position. Timing for the transmit data may also be selected from the FA, FB, FC, or FD optional oscillators provided that the selected oscillator is 1.544 MHz.

There are two types of receivers on the DS1 interface. One receiver accepts the external clock input. This receiver incorporates capactive coupling and an internal schmitt trigger. The other receiver will accpet a RZ coded, differential, AMI data signal at 1.544 MHz (± 100 Hz).

This data will be received either through the RCV INPUT jack or the RCV INPUT of the "D" type connector. The two receive data inputs are tied together internally, therefore, only one should be used at a time. This data signal is then used to develop a recovered clock signal through the use of a phase lock loop (PLL) circuit. The PLL is designed to lock on to a 1.544 MHz (± 100 Hz) data signal with less than 20 sequential zeros (spaces). The DS1 Interface Adaptor will accurately recover a clock signal with all of the patterns available on the FIREBERD except the Space (SP) pattern.

Due to the RZ coding of the DS1 signals, a solid Mark received by the DS1 Interface will cause the FIREBERD RCV DATA LED to turn on.

The clock recovery circuit always provides a receive clock independent of the RCV data. Therefore, with the DS1 interface installed, the Receive Clock Activity LED (RCV CLOCK/TX CLOCK) will always detect a received clock signal. Note that detector does not indicate that the recovered clock is phase locked to the incoming data.

7.8.3 Data-Clock Test Points

This section describes the signals appearing at the test points on the rear panel of the FIREBERD.

The data signal received by the DS1 Interface Adaptor does not require a synchronous clock. Therefore, the clock-data phase relationship at the RCV CLOCK and DATA test points will always be falling edge valid when the PLL is locked onto the received data.

RCV DATA/TX DATA

The signal at this test point is greater than 2.5 volts when the data at the input to the DS1 Interface Adaptor is a Return to zero AMI coded Mark. The signal at this test point is less than .4 volts when the data at the input is a Space. The RZ format will be present at this test point. Therefore, with a solid Mark transmitted the signal at this test point will be a square wave (falling edge valid).

RCV TIMING/-

This test point provides a TTL signal equivalent to the clock signal recovered from the received data. This test point is synchronized (falling edge valid) with the signal at the RCV DATA test point when the FIREBERD shows sync on the front panel SYNC LED.

TX DATA/RCV DATA

This test point provides a TTL equivalent to the data signal at the transmit data output at the DS1 Interface Adaptor. The signal at this test point is greater than 2.5 volts when the data at the TX DATA output is a RZ, AMI coded Mark. This test point will not reflect the RZ or AMI methods of coding.

SEND TIMING/TERM TIMING

With the GENERATOR CLOCK switch in the EXT position and no signal is applied to the FIREBERD BNC connector, this test point provides a TTL signal equivalent to the recovered clock signal or the signal input at the EXT CLK IN on the Interface Adaptor. With a signal applied to the EXT CLOCK IN on the FIREBERD rear panel and the GENERATOR CLOCK switch in the EXT position, this test point provides a TTL signal equivalent to the EXT CLK IN on the FIREBERD rear panel.

TERM TIMING/RCV TIMING

This test point provides a clock signal synchronous with the data output at the interface adaptor. The DS1 Interface Adaptor does not output this signal.

7.8.4 Switch and Connector Description

TX TIMING

Provide that no signal is applied to the FIREBERD rear panel EXT CLK IN, the clock signal selected by the TX TIMING switch on the DS1 Interface Adaptor is accepted by FIREBERD when the GENERATOR CLOCK switch is in the EXT position. (Other 1.544 Mbps timing signals may be selected by FA, FB, FC, or FD if available.)

In the TX TIMING RECOV position, the clock signal used by FIREBERD to generate the transmit data (SD) is the clock recovered from the received data signal (RD). In the TX TIMING EXT position the clock signal used by FIREBERD is the external clock signal input through the BNC connector on the DS1 Interface Adaptor front panel. Note that if the FIREBERD GENERATOR CLOCK switch is in the EXT position and a clock is present at the FIREBERD rear panel BNC input, this clock will be selected independent of the position of the TX TIMING switch.

RCV IMPED

The RCV IMPED switch selects either a 1000 ohm receiver load impedance (BRDG 1000) or 110 ohm receiver load impedance (100 ohm).

7.8.5 Specifications

General:	Operating Frequency - 1.544 MHz (± 100 Hz)
Driver:	Signal Swing - ± 3 volts
Data Receivers:	Load Resistence - 1000/110 ohms.
EXT Clock Receiver:	Wave Type - sine or square; unipolar or bipolar voltage: .5 to 10 vpp
	Load Resistence - 4000 ohms

PLL: Center Frequency - 1.544 MHz

Minimum Pull In Range - ± 100 Hz

TABLE 7-8

D-TYPE CONNECTOR PIN ASSIGNMENTS

PIN	CIRCUIT	DESCRIPTION	COMMENT
1	A	Transmit Data (SD)	output - internally connected to ring of TX OUTPUT.
2		ground	internally connected to pin 4.
3	A	Receive Data (RD)	input - internally connected to ring of RCV INPUT.
4		ground	
5			open
6			open
7			open
8			open
9	B	Transmit Data (SD)	output - internally connected to tip of TX OUTPUT.
10			open
11	B	Receive Data (RD)	input - internally connected to tip of RCV INPUT.
12			open
13			open
14			open
15			open

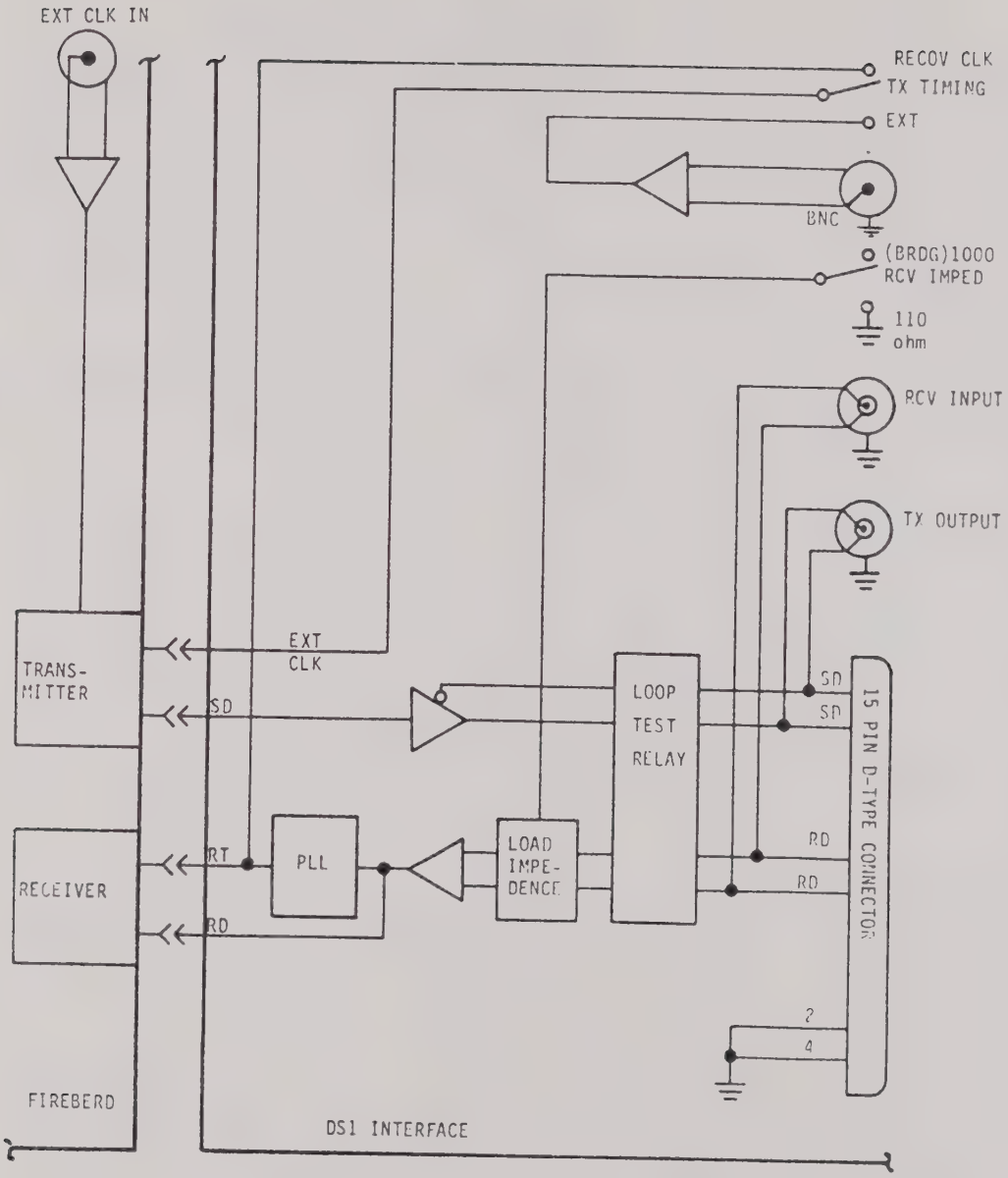


FIGURE 7-13

DS1 Interface Adaptor

7.9 RS-232 DTE INTERFACE ADAPTOR MODULE (MODEL 40112)

7.9.1 Introduction

The FIREBERD RS-232 Interface Adaptor meets the specifications of the Electronic Industries Association's RS-232C Standard dated August, 1969. This interface adaptor, incorporated with the FIREBERD, is designed to act as Data Terminal Equipment for use in the testing of Data Communications Equipment. The data is exchanged in a serial binary format with a synchronous clock.

A female RS-232 "D" type connector is provided on the Interface Adaptor panel. An interconnecting male-to-male cable may be purchased separately. The following sections will provide a functional, switch, test point, and specification description of the RS-232 Interface Adaptor.

7.9.2 Functional Description

The RS-232 DTE Interface Adaptor is designed to convert between the serial binary signals specified by the EIA RS-232C standard and the TTL signals used in the FIREBERD.

Drivers are provided for the Transmit Clock, Transmit Data, Request to Send (RTS), and Data Terminal Ready (DTR). The RTS output is controlled by a FIREBERD front panel switch. The DTR output is tied high on Rev A modules. The DTR output on Rev B or higher modules is controllable from the TR(DTR) switch on the front of the FIREBERD.

There are six receivers, three of which directly drive FIREBERD front panel signaling LEDs. The Transmit Signal Element Timing (DCE Source) is sent to the transmit section of the FIREBERD where it may be selected for use by the GENERATOR CLOCK switch. The other two receiver signals (RCV Timing and RCV Data) are sent to the receive section of the FIREBERD for error analysis.

The interface adaptor also includes a loop test relay. When the LOOP TEST switch is in the LOOP position on the FIREBERD front panel, this relay will connect the TX Data and Clock driver outputs to the RCV Data and Clock receiver inputs. It will also disconnect the driver and receiver signals from the interface connector.

7.9.3 Data-Clock Test Points

This section describes the phase relationship between the RS-232C DTE Interface Adaptor data and clock input signals and the FIREBERD Rear Panel Test Points.

RCV DATA/TX DATA

The signal at this test point is greater than 2.5 volts when the received data at the BB input is less than -3 volts (Mark). The signal at the test point is less than .4 volts when the signal at the BB input is greater than +3 volts (Space).

RCV TIMING/-

This test point provides a TTL signal, equivalent to the Receiver Signal Element Timing (DD) signal at the input to the RS-232 Interface Module. With the RCV CLK (DD) switch in the NORMAL position, the signal at this test point is greater than 2.5 volts when the signal at the DD input is greater than +3 volts. The test point signal is less than .4 volts when the signal at the DD input is less than -3 volts. When the RCV CLK (DD) switch is in the INVERT position, the signal at this test point is inverted with respect to the signal at the DD input.

TX DATA/RCV DATA

This test point provides the TTL equivalent of the signal at the

Transmitted Data (BA) output of the RS-232 Interface Module. The signal at this test point is greater than 2.5 volts when the signal at the BA output is less than -3 volts (Mark). The test point signal is less than .4 volts when the signal at the BA output is greater than +3 volts (Space).

SEND TIMING/TERM TIMING

The signal at this test point is the TTL equivalent of the signal at the Transmit Signal Element Timing (DB) input at the Interface Adaptor. This test point provides a signal of greater than 2.5 volts when the signal at the DB input is greater than +3 volts. The signal is less than .4 volts at the test point when the DB input is less than -3 volts.

TERM TIMING/RCV TIMING

This test point provides a TTL signal equivalent to that signal at the Transmit Signal Element Timing output (DA) at the RS-232 Interface Adaptor. This test point is greater than 2.5 volts when the signal at DA is greater than +3 volts. The test point signal is less than .4 volts when the signal at DA is less than -3 volts.

7.9.4 Switch and Indicator Description

RCV CLK (DD)

The RCV CLK (DD) switch controls the polarity of the received clock inside the FIREBERD. In the normal (NORM) position, FIREBERD is prepared to accept data which is falling edge (ON-OFF) valid as specified in the EIA RS-232C Standard. In the INVERT position, the FIREBERD is prepared to receive data that is rising edge (OFF-ON) valid due to the inverted received clock.

TX CLK (DA or DB)

The TX CLK switch controls the polarity of the clock used to develop the transmit clock and data signals inside the FIREBERD. The NORM position transmits data-clock phasing as stated in the RS-232C Specification. In the INVERT position, the transmit data and clock phasing will be inverted with respect to the RS-232C Specification.

NON-STANDARD TIMING

This indicator will illuminate when either or both clock invert switches are in the INVERT position.

7.9.5 Specifications

General:	Maximum Speed - 20 kb/s (per RS-232C) Data Polarity - Data Mark/binary "1"; control lead OFF: less than -3 volts. Data Space/binary "0"; control lead ON: greater than 3 volts. Output Rise Time - greater than 20 microseconds. Generator Impedance - less than 100 ohms.
Drivers:	Signal Swing - 10V $\pm$ 2V into 7K ohms typical. Short Circuit Current - less than 100 mA
Receivers:	Load Impedance - 3K to 7K ohms. Maximum Input Voltage - $\pm$ 25V

TABLE 7-9

RS-232C DTE INTERFACE CONNECTOR PIN ASSIGNMENTS

PIN	CIRCUIT	RS-232C DESCRIPTION	Lead Status on FIREBERD Interface Adaptor
1	AA	Protective Ground	internally connected to Pin 7
2	BA	Transmitted Data	output
3	BB	Received Data	input
4	CA	Request to Send	output
5	CB	Clear to Send	input
6	CC	Data Set Ready	input
7	AB	Signal Ground (Common Return)	internally connected to Pin 1
8	CE	Received Line Signal Detector	input
9	--	(Reserved for Data Set Testing)	open
10	--	(Reserved for Data Set Testing)	open
11		Unassigned (see Sec. 2.3)	open
12	SCF	Sec. Received Line Signal Detector	open
13	SCB	Sec. Clear to Send	open
14	SBA	Secondary Transmitted Data	open
15	DB	Transmit Signal Element Timing (DCE Source)	input
16	SBB	Secondary Received Data	open

TABLE 7-9 (continued)

RS-232C DTE INTERFACE CONNECTOR PIN ASSIGNMENTS

PIN	CIRCUIT	RS-232C DESCRIPTION	Lead Status on FIREBERD Interface Adaptor
17	DD	Receiver Signal Element Timing (DCE Source)	input
18		Unassigned	open
19	SCA	Sec. Request to Send	open
20	CD	Data Terminal Ready	output
21	CG	Signal Quality Detector	open
22	CE	Ring Indicator	open
23	CH/CI	Data Signal Rate Selector (DCE/DTE Source)	open
24	DA	Transmit Signal Element Timing (DTE Source)	output
25		Unassigned	open

7.10 RS-232 DTE/DCE INTERFACE ADAPTOR MODULE (MODEL 40236)

7.10.1 Introduction

The RS-232 DTE/DCE Interface Adaptor was designed to meet the Electronics Industries Association (EIA) RS-232C Interface Standard. This interface incorporated with the FIREBERD enables the FIREBERD to act as Data Terminal Equipment (DTE) for use in testing Data Communications Equipment (DCE). A special adaptor cable, included with the interface, allows the FIREBERD to act as a DCE for testing DTE. The data is exchanged in a serial binary format with a synchronous clock.

7.10.2 Operation as Data Terminal Equipment

7.10.2.1 Functional Description - DTE Operation

The RS-232 DTE/DCE Interface Adaptor converts the signal characteristics specified by the RS-232 specification to the TTL signals used by the FIREBERD. The Adaptor Cable should not be attached and the DCE (DA)/DCE (DB)/DTE switch on the interface should be in the DTE position.

In a typical RS-232 circuit, the DCE supplied timing to the DTE (FIREBERD) on the Transmit Signal Element Timing (DB) lead. With FIREBERD's GENERATOR CLOCK switch in the EXT position, FIREBERD will generate Transmit Data (BA) and Transmit Signal Element Timing (DA) coincident with the clock received on the Transmit Signal Element Timing (DB).

If the FIREBERD's GENERATOR CLOCK switch is set for any of the internal rates (including FA, FB, FC, or FD if so equipped) the FIREBERD will ignore the transmit Signal Element Timing (DB) and generate Transmit Data (BA) and Transmit Timing (DA) coincident with the selected

internal rate. Data and Clock signals are received on the Receive Data (BB) and Receiver Signal Element Timing (DD) leads respectively for error analysis.

Two toggle switches on the FIREBERD front panel allow Request to Send (RTS) and Data Terminal Ready (DTR) to be turned on and off. Clear to Send (CTS), Data Set Ready (DSR), and Receive Line Signal Detector (RLSD) are received and their status displayed on the FIREBERD front panel.

When the LOOP TEST switch on the front panel of the FIREBERD is placed in the LOOP position, relays on this module will connect the transmit clock and data outputs to the receive clock and data inputs. User connections need not be removed during loop test. External timing for loop test can be provided on the TX Signal Element Timing (DB) lead (DCE source) or through the rear panel BNC connector. Loop test tests actual drivers and receivers that are used in normal operation.

7.10.2.2 Switch and Indicator Description - DTE Operation

Two clock invert switches are provided on the interface panel. Setting the TRANSMIT CLOCK INVERT switch to the INV (down) position causes Transmit Data to be valid on the rising edge of the selected clock source instead of the falling edge (normal). Setting the RECEIVE CLOCK INVERT switch to the INV (down) position causes FIREBERD to expect valid Receive Data (BB) on the rising edge of Receive Signal Element Timing (DD) instead of the falling edge (normal). A NON-STANDARD TIMING indicator will illuminate when either or both clock invert switches are in the INV position.

7.10.2.3 Data/Clock Test Points - DTE Operation

This section describes the relationship between the signals at the interface connector and the FIREBERD rear panel test points.

RCV DATA/TX DATA

The signal at this point is greater than 2.5 volts when the Receive Data at the (BB) input is less than -3 volts (Mark). The signal at the test point is less than .4 volts when the signal at the (BB) input is greater than +3 volts (Space).

RCV TIMING

This test point provides a TTL signal equivalent to the Receive Signal Element Timing (DD) Signal at the input to the interface module. With the RCV CLK (DD) switch in the normal position, the signal at this test point is greater than 2.5 volts when the signal at the (DD) input is greater than +3 volts. The test point signal is less than .4 volts when the signal at the (DD) input is less than -3 volts. When the RCV CLK (DD) switch is in the INV position, the signal at this test point is inverted with respect to the signal at the (DD) input.

TX DATA/RCV DATA

This test point provides the TTL equivalent of the signal at the Transmit Data (BA) output. The signal at this test point is greater than 2.5 volts when the signal at the (BA) output is less than -3 volts (Mark). The test point signal is less than .4 volts when the signal at the (BA) output is greater than +3 volts (Space).

SEND TIMING/TERM TIMING

The signal at this test point is the TTL equivalent of the signal at the Transmit Signal Element Timing (DB) input at the interface connector. This test point provides a signal of greater than 2.5 volts when the signal at the (DB) input is greater than +3 volts. The signal is less than .4 volts at the test point when the (DB) input is less than -3 volts.

TERM TIMING/RCV TIMING

This test point provides the TTL signal equivalent to the signal at the Transmit Signal Element Timing output (DA) at the Interface Connector. This test point is greater than 2.5 volts when the signal at (DA) is greater than +3 volts. The test point signal is less than .4 volts when the signal at (DA) is less than -3 volts.

7.10.3 Operation As Data Communications Equipment

7.10.3.1 Functional Description - DCE Operation

The FIREBERD RS-232 DTE/DCE Interface Adaptor can easily be configured to look like Data Communications Equipment (DCE) for testing of Data Terminal Equipment (DTE) by using a special adaptor cable (included).

NOTE: The Adaptor Cable must be connected in order to select either DCE (DA) or DCE (DB) on the interface panel. The interface defaults to the DTE operation in the absence of the adaptor cable. All signals are referred to by the name of the signal at the cable output - not the end connected to the FIREBERD.

In a typical RS-232 circuit, the DCE (FIREBERD) supplies timing to the DTE on the Transmit Signal Element Timing (DB). The DTE will return Transmit Data (BA) and Transmit Signal Element Timing (DA) to the FIREBERD for error analysis.

Two DCE timing modes are selectable on the interface panel: DCE (DA) and DCE (DB). In the DCE (DA) position, TX data and the DTE source timing signal (DA) are sent to the receive section of FIREBERD for error analysis. In the DCE (DB) position, TX data and the internally generated DB are sent to the receive section of FIREBERD for error analysis.

With FIREBERD's GENERATOR CLOCK switch set to the EXT position, RCV Data and Receive Signal Element Timing will be generated coincident with transmit signal element timing (DA) from the DTE. (Note that with the DTE signal DA must not be generated from the DCE TX Timing Signal (DB). FIREBERD may also generate RCV Data and RCV Timing coincident with any of the internal rates (including FA, FB, FC, and FD if so equipped).

When the LOOP TEST switch on the front panel of the FIREBERD is placed in the LOOP position, a relay on the interface module will connect transmit clock and data to receive clock and data. User connections need not be removed during loop test. External timing for loop test can be provided on the Transmit Signal Element Timing (DA) lead or through the rear panel BNC connector. Loop test tests actual drivers and receivers that are used in normal operation. Note that TX Timing (DB) driver is not tested nor is the adaptor cable.

Two toggle switches on the FIREBERD front panel allow Receive Line Signal Detector (RLSD) and Data Set Ready (DSR) to be turned on and off in DCE mode. Data Terminal Ready (DTR) and Request to Send (RS) are received and their status displayed on the FIREBERD front panel. The DTE generated Request to Send (RS) is tied directly back to the DTE received Clear to Send (CS) in addition to being displayed on the FIREBERD front panel.

7.10.3.2. Switch and Indicator Description - DCE

Two clock invert switches are provided on the Interface Panel. The TRANSMIT CLOCK INVERT switch in the INVERT (down) position causes FIREBERD to expect valid TX Data on the rising edge of the selected clock source instead of the falling edge (Normal). Setting the RCV CLOCK INVERT switch down causes FIREBERD to generate valid Receive Data on the rising edge of the selected clock source instead of the falling edge (Normal). A NON-STANDARD TIMING indicator will illuminate when either or both clock invert switches are in the INVERT position.

7.10.3.3 Data/Clock Test Points - DCE Operation

This section describes the phase relationship between the interface connector data and clock signals and the FIREBERD rear panel test points.

RCV DATA/TX DATA

This signal at this test point is greater than 2.5 volts when the Transmit Data at the (BA) input to the adaptor cable is less than -3 volts (Mark). The signal at the test point is less than .4 volts when the signal at (BA) is greater than +3 volts (Space).

TX DATA/RCV DATA

This test point provides the TTL equivalent of the signal at the BB output. The signal at this test point is greater than 2.5 volts when the signal at the BB output is less than -3 volts (Mark). The test point signal is less than .4 volts at the test point when the BB output is greater than +3 volts (Space).

SEND TIMING/TERM TIMING

The signal at this test point is the TTL equivalent to that signal at the Transmit Signal Element Timing (DB) input. This test point provides a signal 2.5 volts when the signal at the DB input is greater than +3 volts. the signal is less than .4 volts at the test point when the DB input is less than -3 volts.

TERM TIMING/RCV TIMING

This test point provides a TTL signal equivalent to that at the Receive Timing Signal (DD) output. This test point is greater than 2.5 volts when the signal at DD is greater than +3 volts and less than .4 volts when DD is less than +3 volts.

7.10.4 Specifications

General:	Maximum Speed - 20 kb/s (per RS-232C) Data Polarity - Data Mark/binary "1"; control lead OFF: less than -3 volts. Data Space/binary "0"; control Lead ON: greater than +3 volts.
Drivers:	Output rise time - greater than 20 microseconds. Generator Impedance - less than 100 ohms Signal Swing - 10V $\pm$ 2V into 7K ohms typical Short Circuit Current - less than 100 mA
Receivers:	Load Impedance - 3K to 7K ohms Maximum Input Voltage - $\pm$ 25V

TABLE 7-10

RS-232C DTE/DCE CONNECTOR PIN ASSIGNMENTS

Pin	Circuit	RS-232C Description	LEAD STATUS	
			Interface Panel Connector (DTE Operation)	DTE End of Adaptor Cable (DCE Operation)
1	AA	Protective Ground	internally connected to Pin 7	
2	BA	Transmitted Data	output	input
3	BB	Received Data	input	output
4	CA	Request to Send	output	input
5	CB	Clear to Send	input	connected to Pin 4
6	CC	Data Set Ready	input	output
7	AB	Signal Ground (Common Return)	internally connected to Pin 1	
8	CF	Received Line Signal Detector	input	output
9	--	(Reserved for Data Set Testing)	open	open
10	--	(Reserved for Data Set Testing)	open	open
11		Unassigned	open	open
12	SCF	Secondary Received Line Signal Detector	open	open
13	SCB	Secondary Clear to Send	open	open
14	SBA	Secondary Transmitted Data	open	open
15	DB	Transmit Signal Element Timing (DCE Source)	input	output
16	SBB	Secondary Received Data	open	open
17	DD	Receiver Signal Element Timing	input	output

TABLE 7-10 (continued)

RS-232C DTE/DCE CONNECTOR PIN ASSIGNMENTS

Pin	Circuit	RS-232C Description	LEAD STATUS	
			Interface Panel Connector (DTE Operation)	DTE End of Adaptor Cable (DCE Operation)
18	DD	Unassigned	FIREBERD use only	open
19	SCA	Secondary Request to Send	open	open
20	CD	Data Terminal Ready	output	input
21	CG	Signal Quality Detector	open	open
22	CE	Ring Indicator	open	open
23	CH/CI	Data Signal Rate Selector (DCE/DTE Source)	open	open
24	DA	Transmit Signal Element Timing (DCE Source)	output	input
25	--	Unassigned	FIREBERD use only	open

7.11 RS-232 ISOCHRONOUS (CLOCK RECOVERY)/SYNCHRONOUS INTERFACE ADAPTOR (MODEL 40232)

7.11.1 Introduction

The Model 40232 RS-232 Isochronous/Synchronous Interface Adaptor allows a FIREBERD to test both synchronous and isochronous (bit timing recovery) communications channels. This Interface Adaptor enables a FIREBERD to act as a Data Terminal Equipment (DTE) for use in testing Data Communications Equipment (DCE).

Data is exchanged in serial binary format either with a synchronous clock signal (synchronous operation) or without a clock signal (asynchronous operation). Data, signaling, and other connections are made via a standard 25-pin female "D" connector.

The following sections will provide specifications and functional descriptions of the RS-232 Isochronous Interface Adaptor.

7.11.2 Functional Description

The RS-232 Isochronous/Synchronous Interface Adaptor is used to convert between the TTL signals used within the FIREBERD and signals conforming to EIA Standard RS-232C.

The Interface Adaptor has three modes of operation:

1. Synchronous (DCE Source) - data is transmitted and received with a synchronous clock and timing is provided by the DCE under test or through the FIREBERD BNC connector.

2. Synchronous (Internal or Baud Rate Source) - data is transmitted and received with a synchronous clock and timing is generated either by the FIREBERD internal clock sources or by the Interface Adaptor baud rate generator.

3. Asynchronous - data is transmitted and received without a clock signal. Transmit timing is generated by the Interface Adaptor and receive timing is recovered internally from the data transitions.

The Interface Adaptor contains a loop test multiplexer which connects the TTL-level transmit data and clock signal directly to the FIREBERD receive data and clock inputs when the FIREBERD LOOP TEST switch is placed in the LOOP position. This loop test is useful in verifying correct operation of the FIREBERD and the Interface Adaptor. When in the loop test mode, the transmit data and clock (if used) signals are unaffected. The receive data and clock (if used) terminations are not affected by the loop test mode, although these signals do not reach the FIREBERD itself.

7.11.3 Synchronous (DCE Source) Operation

When operating in the Synchronous (DCE Source) mode, the GENERATOR CLOCK switch on the FIREBERD must be in the EXT position. The desired clock signal can then be provided either through the FIREBERD BNC connector or via Pin 15 of the "D" connector.

Transmit data and clock will be available at connector Pin 2 and 24, respectively. Receive data and clock are expected at connector Pin 3 and 17, respectively.

7.11.4 Synchronous (Internal or Baud Rate Source) Operation

When operating in the Synchronous (Internal or Baud Rate Source) mode, transmit timing is generated by one of two sources:

1. The FIREBERD GENERATOR CLOCK switch, selecting any internal frequency including FA, FB, FC or FD if so equipped.

2. The Interface Adaptor BAUD RATE switch with the FIREBERD GENERATOR CLOCK switch set to "EXT." Any of eleven baud rates* can be selected.

Transmit data and clock will be available at connector Pin 2 and 24, respectively. Receive data and clock are expected at connector Pins 3 and 17, respectively.

Note that any signals appearing at connector Pin 15 are ignored by the Interface Adaptor.

7.11.5 Asynchronous Operation

When operating in the Asynchronous mode, the FIREBERD GENERATOR CLOCK switch must be set to the EXT position. Any of eleven transmit baud rates may be selected via the BAUD RATE switch on the Interface Adaptor. Receive timing is generated by the Interface Adaptor through the use of an all-digital bit synchronizer (clock recovery circuit).

Transmit data will be available from connector pin 2 and receive data is expected at connector pin 3. No transmit timing is provided in the

---

*At 75 baud, the "Seconds," Error Seconds," and "Print Timer" functions will operate slower than normal and should not be used.

Asynchronous mode and pin 24 is held at a constant mark. Signals appearing at connector pins 15 and 17 are ignored by the Interface Adaptor.

Because the clock recovery circuit requires receive data transitions for synchronization, the Isochronous Interface Adaptor will operate with any of the FIREBERD standard test patterns except the Mark and Space patterns.

7.11.6 Signaling

The following signaling signals are supported by the Isochronous Interface Adaptor and the FIREBERD:

1. Request to Send (CA-pin 4) - Controlled by FIREBERD front panel switch.

2. Clear to Send (CB-pin 5) - displayed by FIREBERD.

3. Data Set Ready (CC-pin 6) - displayed by FIREBERD.

4. Data Terminal Ready (CD-pin 20) - controlled by FIREBERD front panel switch.

5. Receive Line Signal Detect (CF-pin 8) - displayed by FIREBERD.

7.11.7 Specifications

General:	Maximum Synchronous Speed	20 kbits/sec nominal
	Asynchronous Baud Rates	75, 150, 300, 600, 1200, 1800, 2400, 3600, 4800, 7200, 9600 baud

Line Drivers:	Slew Rate.	30 volts per micro second maximum
	Impedance.	100 ohms maximum
	Short Circuit Current.	50 mA maximum
	Data Mark (binary 1)	-3.0 volts maximum
	Data Space (binary 0).	+3.0 volts minimum
	Signal Swing (typ, 7K ohm load).	10 $\pm$ 2 volts
Line Receivers:	Load Impedance	3000 ohms minimum 7000 ohms maximum
	Maximum Input Voltage.	$\pm$ 25 volts
	Data Mark (binary 1)	0.0 volts maximum
	Data Space (binary 0).	2.0 volts minimum

TABLE 7-11

RS-232 ISOCHRONOUS/SYNCHRONOUS INTERFACE ADAPTOR

PIN ASSIGNMENTS

Pin #	Signal Name	Direction	Comment
1	AA-GND	--	
2	BA-TX DATA	To DCE	
3	BB-RCV DATA	From DCE	
4	CA-REQUEST TO SEND	To DCE	Front Panel Controlled
5	DB-CLEAR TO SEND	From DCE	
6	CC-DATA SET READY	From DCE	
7	AB-GND	--	
8	CF-RCV LINE SIGNAL DETECTOR	From DCE	
9	Not used	--	
10	Not used	--	
11	Not used	--	
12	Not used	--	
13	Not used	--	
14	Not used	--	
15	DB-TRANSMIT TIMING (DCE SOURCE)	From DCE	Not used in Asynchronous mode
16	Not used	--	
17	DD-RECEIVE TIMING (DCE SOURCE)	From DCE	Not used in Asynchronous mode
18	Not used	--	
19	Not used	--	
20	CD-DATA TERM READY	To DCE	Front Panel Controlled
21	Not used	--	
22	Not used	--	
23	Not used	--	
24	DA-TRANSMIT TIMING	To DCE	Disabled in Asynchronous mode
25	Not used	--	

7.12 RS-232 ASYNCHRONOUS (CHARACTER) DTE/DCE CHARACTER INTERFACE ADAPTOR MODULE (MODEL 40234)

7.12.1 Introduction

The RS-232 Asynchronous Character Interface Adaptor permits the FIREBERD to test a wide variety of character-oriented equipment and systems. The Interface Adaptor normally acts as a DTE (Data Terminal Equipment) but by using a specially designed cable (included) can act as a DCE (Data Communications Equipment).

Data is exchanged in serial binary format with all signals conforming to EIA Standard RS-232-C. Connections to the Interface Adaptor are made via a female 25-pin "D" connector.

Data is transmitted and received in a character format, with each character containing a start bit, 5 to 8 data bits, optional parity bit, and one or more stop bits. In order to make the Character Interface Adaptor versatile, the baud rate, number of data bits per word, parity mode, and number of stop bits are switch controlled.

The following sections will provide functional descriptions and specifications for the Asynchronous Character Interface Adaptor.

7.12.2 Functional Description

The Asynchronous Character Interface Adaptor is designed to convert between the TTL signals used within the FIREBERD and signals complying with EIA Standard RS-232-C. Data generated within the FIREBERD is placed in a character format (see Figure 7-14) and transmitted at the user-selected baud rate. Received characters are stripped of start, stop, and parity bits and the extracted data is returned to the FIREBERD for error analysis. No transmit clock signals are provided and no receive clock signals are expected.

Figure 7-14

Asynchronous Character Formats

(a) longest possible character

(b) shortest possible character

(c) 1½ stop bit (5 data bits only)

Several switches are provided on the Interface Adaptor allowing the user to tailor the character format and baud rate to meet equipment requirements. These switches are described below:

BAUD RATE SELECTOR - Any of fourteen baud rates may be selected by the user, covering the standard rates from 75* to 9600 baud. Note that the FIREBERD GENERATOR CLOCK switch must be set to the EXT position. Both the transmit and receive baud rates are selected by the BAUD RATE SELECTOR switch.

SCALE UPPER/LOWER - The BAUD RATE SELECTOR switch has two scales - an upper (1200 to 9600 baud) and a lower (75 to 600 baud). The SCALE switch selects which scale is to be used for baud rate generation.

NUMBER OF DATA BITS - 5, 6, 7, or 8 data bits can be included in each character.

PARITY SELECT - A parity bit can be appended to the data in each character if desired. The PARITY SELECT switch has three positions: EVEN selects even parity; ODD selects odd parity; NO PARITY causes the parity bit to be omitted.

NUMBER OF STOP BITS - Selects the number of stop bits used to end the character. In the 1SB position, one stop bit is selected. In the 2SB position, two stop bits are transmitted except when 5 data bits are transmitted; only 1 1/2 stop bits are then transmitted.

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*At baud rates of 75, 150, or 300 baud, the "Seconds," "Error Seconds," and "Print Timer" functions will operate slower than normal. These timing functions are designed to be synchronous with the receive clock and operation at low baud rates prevents sufficient transitions per unit time to assure correct timing operations.

7.12.3 Signaling

The following RS-232-C signaling leads are supported when the Interface Adaptor is used as a DTE (Data Terminal Equipment):

1. REQUEST TO SEND (CA) - controlled by FIREBERD front panel switch.

2. CLEAR TO SEND (CB) - displayed by FIREBERD.

3. DATA SET READY (CC) - displayed by FIREBERD.

4. DATA TERMINAL READY (CD) - controlled by FIREBERD front panel switch.

5. RECEIVE LINE SIGNAL DETECT (CF) - displayed by FIREBERD.

The following signaling leads are supported when the Interface Adaptor is used as DCE (Data Communications Equipment) using the special cable (see Figure 7-15):

1. REQUEST TO SEND (CA) - displayed by FIREBERD. Note that circuit CA is connected directly to circuit CB below at the DTE end of the cable.

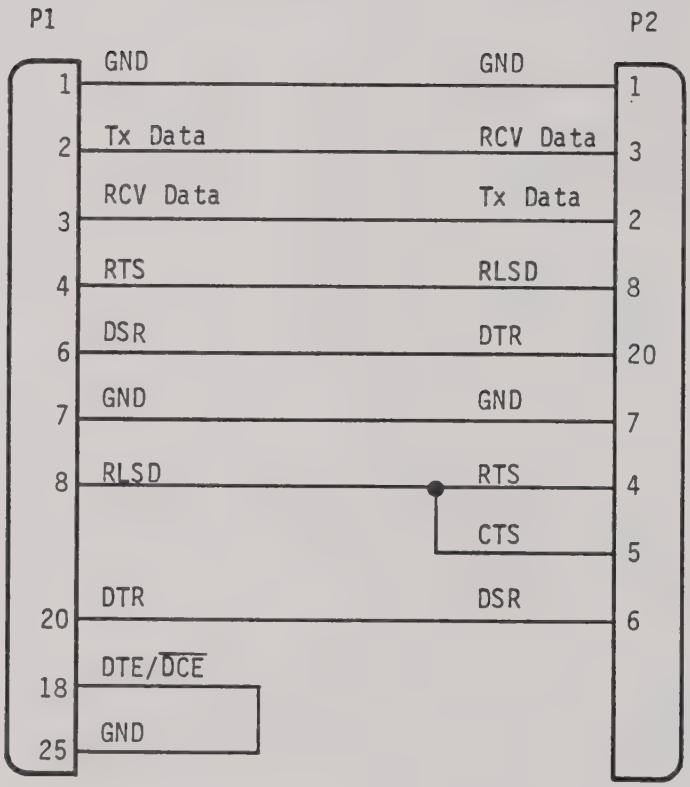
2. CLEAR TO SEND (CB) - tied directly to circuit CA above at the DTE end of the special cable.

3. DATA SET READY (CC) - controlled by front panel switch.

4. DATA TERMINAL READY (CD) - displayed by FIREBERD.

5. RECEIVED LINE SIGNAL DETECT (CF) - controlled by front panel switch.

Figure 7-15
Asynchronous Character DTE/DCE Cable



P1: 25-Pin D-Subminiature, Male
P2: 25-Pin D-Subminiature, Female
Cable Length: 6 feet (72 inches)

7.12.4 FIREBERD Test Points

Transmit data is taken from the FIREBERD in bursts with the desired number of data bits (5, 6, 7, or 8) being extracted approximately once per transmitted character. The clock signals used for obtaining data from the FIREBERD are substantially faster than the transmitted baud rate and are not necessarily coincident with the transmitted bit transitions. Figure 7-16 shows the TX Data, TX Clock and transmitted character relationships.

Received data is extracted from each character and is sent to the FIREBERD using a clock signal at the selected baud rate. Figure 7-17 shows the RCV Data, RCV Clk, and received character relationships.

7.12.5 Applications Information

The following information is provided to aid in using the Asynchronous Character Interface Adaptor to best advantage.

As the Interface Adaptor is shipped from the factory, the transmitted character stream is continuous, i.e., the final stop bit of one character is immediately followed by the start bit of the next character.

The data receiver is capable of handling baud rate differences (between transmit and receive baud rates) of approximately $\pm$ 3%. Note that excessive time between received characters may be interpreted by the FIREBERD as a clock loss (resulting in a sync loss), primarily at the lower baud rates.

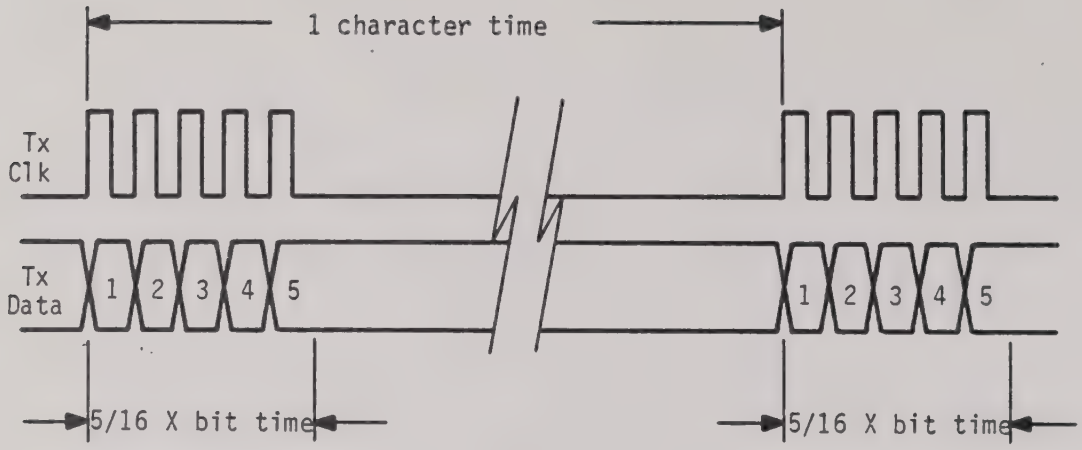


Figure 7-16 Tx Clk, Tx Data Test Points (5 data bits)

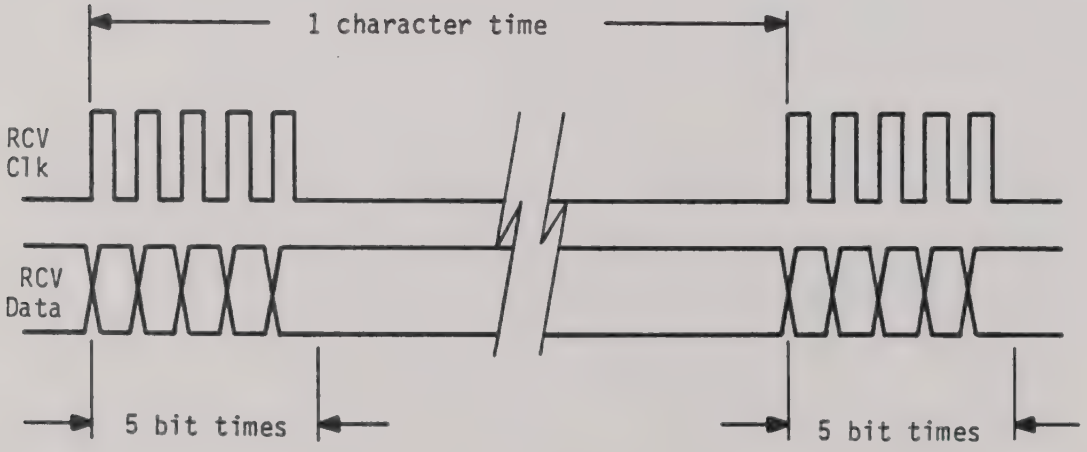


Figure 7-17 RCV Clk, RCV Data Test Points (5 data bits)

Under most testing conditions, the factory-shipped Asynchronous Character Interface Adaptor will perform satisfactorily. However, if the Interface Adaptor baud rate generator frequency is higher than that of the equipment under test and if the testing period is long or the frequency difference is large, data overruns can occur in the equipment under test. This is due to the fact that data is being sent to the equipment under test faster than it is being returned to the FIREBERD. Two methods exist for avoiding the problems associated with this condition:

1. Many asynchronous receivers search only for a single stop bit; setting the NUMBER OF STOP BITS switch to the "2SB" position effectively inserts a marking pause between characters.

2. If solution (1) is not sufficient, the Interface Adaptor has two wire jumpers which can be changed (consult the factory for details) to insert a brief marking period (about 50% of a bit time) between transmitted characters.

The Asynchronous Character Interface Adaptor transmitted characters are, as factory-configured, independent of the signaling information. If it is necessary, the transmitted data can be held marking when RTS (circuit CA) is not asserted or can be held marking when any of RTS (CA), CTS (CB), or DTR (CD) are not asserted. Consult the factory for the desired modification instructions.

7.12.6 Specifications

Selectable Baud Rates

Lower Scale.	75,110, 134.5, 150, 200, 300, 600 baud
Upper Scale.	1200, 1800, 2400, 3600, 4800, 7200, 9600 baud

Number of Data Bits Per Character	5, 6, 7, 8 bits
Number of Start Bits Per Character	1 bit
Number of Stop Bits Per Character	1, 2 bits (1, 1 1/2 for 5 data bits)
Parity Bit Control	Even, odd, no parity

Line Drivers

Data Mark/Off/Binary 1	-6.0 volts maximum
Data Space/On/Binary 0	+6.0 volts minimum
Signal Swing (typical 7K ohms load)	± 10 volts
Slew Rate	30 volts/microsec maximum
Impedance	100 ohms maximum
Short Circuit Current	50 mA maximum

Line Receivers

Load Impedance	3000 ohms minimum 7000 ohms maximum
Maximum Input Voltage.	± 25 volts
Data Mark/Off/Binary 1	0.0 volts maximum
Data Space/On/Binary 0	2.0 volts minimum

Table 7-12

Asynchronous Character Interface Adaptor Pin Assignments

(DTE Operation)

Pin #	Signal Name	Direction	Comment
1	(AA) Ground	--	--
2	(BA) Tx Data	To DCE	--
3	(BB) Rcv Data	From DCE	--
4	(CA) Request To Send	To DCE	Front Panel Controlled
5	(CB) Clear To Send	From DCE	Front Panel Displayed
6	(CC) Data Set Ready	From DCE	Front Panel Displayed
7	(AB) Ground	--	--
8	(CF) Rcv Line Signal Detect	From DCE	Front Panel Displayed
9	- not used -	--	--
10	- not used -	--	--
11	- not used -	--	--
12	- not used -	--	--
13	- not used -	--	--
14	- not used -	--	--
15	- not used -	--	--
16	- not used -	--	--
17	- not used -	--	--
18	FIREBERD Use Only	--	--
19	- not used -	--	--
20	(CD) Data Terminal Ready	To DCE	Front Panel Controlled
21	- not used -	--	--
22	- not used -	--	--
23	- not used -	--	--
24	- not used -	--	--
25	FIREBERD Use Only	--	--

Table 7-13

Character Interface Adaptor Cable Pin Assignments

(DCE Operation)

Pin #	Signal Name	Direction	Comment
1	(AA) Ground	--	--
2	(BA) TxData	From DTE	--
3	(BB) Rcv Data	To DTE	--
4	(CA) Request To Send	From DTE	Front Panel Displayed
5	(CB) Clear To Send	To DTE	Tied directly to circuit CA
6	(CC) Data Set Ready	To DTE	Front Panel Controlled
7	(AB) Ground	--	--
8	(CF) Rcv Line Signal Detect	To DTE	Front Panel Controlled
9	- not used -	--	--
10	- not used -	--	--
11	- not used -	--	--
12	- not used -	--	--
13	- not used -	--	--
14	- not used -	--	--
15	- not used -	--	--
16	- not used -	--	--
17	- not used -	--	--
18	- not used -	--	--
19	- not used -	--	--
20	(CD) Data Terminal Ready	From DTE	Front Panel Displayed
21	- not used	--	--
22	- not used -	--	--
23	- not used -	--	--
24	- not used -	--	--
25	- not used -	--	--

7.13 LAB INTERFACE ADAPTOR MODULE (MODEL 40204)

7.13.1 Introduction

The Lab Interface Adaptor Module is a versatile interface unit which allows the FIREBERD to test a wide variety of data handling devices. Capable of driving any load from 50 ohms to high impedances, with user-selectable receiving impedances, the Lab Interface allows the user to select bipolar or unipolar, balanced or unbalanced operating modes.

Data is exchanged in a serial binary format with a synchronous clock signal. All connections with the Lab Interface are made through BNC connectors.

The following sections will provide descriptions and the specifications for the Lab Interface Adaptor.

7.13.2 Functional Description

The Lab Interface Adaptor Module is designed to convert between the TTL signals used within the FIREBERD and the user-selected signal type.

Data generated in the FIREBERD is transmitted through the TX DATA jack. The synchronous transmitted clock signal is sent through the TX CLK OUT jack. Data is returned to the FIREBERD for error analysis through the RCV DATA jack. The synchronous returned clock is sent through the RCV CLK jack.

Timing for the transmitted data signal may be developed either by selecting one of the FIREBERD's internal clock signals or by setting the FIREBERD GENERATOR CLOCK switch to the EXT position and providing a clock signal via the EXT TX CLK IN jack on the Interface Module or the FIREBERD rear panel BNC connector.

The Lab Interface Adaptor also includes a loop test multiplexer designed to connect the TTL-Level transmit data and clock signals directly to the FIREBERD TTL-Level receive data and clock inputs when the LOOP TEST switch is in the LOOP position. When in the loop test mode, the Lab Interface transmit data and clock signals are unaffected. The receive data and clock signal terminations are not affected by the loop test mode, although these signals do not reach the FIREBERD itself.

7.13.3 Switch Operation and Control

The Lab Interface Adaptor has three switches each with four positions affecting the operation of the unit. By properly selecting the switch positions, any of up to 64 operating modes may be accommodated.

INPUT IMPEDANCE SWITCH

The INPUT IMPEDANCE switch affects the three inputs: RCV DATA, RCV CLK, and EXT TX CLK IN. When in the 50 OHMS position, the switch places a 50 ohm terminating resistor across each of the three inputs. When placed in the 75 OHMS position, a 75 ohm resistor terminates each of the three inputs. The 100 OHM position provides a 100 ohm terminating resistor and the 8K OHMS position allows the input signals to go directly to the line receiver integrated circuits with no other resistive termination.

MODE SWITCH

The MODE switch controls the mode of operation of all five data and clock jacks. Two major modes of operation are available: The Bipolar configuration (both positive and negative with respect to ground) and the Unipolar configuration (positive only with respect to ground). For each of these two modes, an Unbalanced arrangement (the outer conductor tied directly to ground) or a Balanced arrangement (the outer connector used as a complementing driver) are selectable.

Figure 7-18 shows the output voltage levels and the signal arrangements for each of the four selectable modes. Figure 7-19 shows the voltage levels required by the RCV DATA, RCV CLK, and EXT TX CK IN signal jacks for proper operation. Note that the voltage levels required are independent of the terminating impedances.

CLOCK PHASING SWITCH

The CLOCK PHASING switch controls the data and clock phase relationships for both the transmit and receive ports. For both the transmit and receive sides, either falling-edge valid or rising-edge valid can be selected. Figure 7-20 shows the four available switch positions and the resultant data/clock relationships.

7.13.4 Receive Test Points

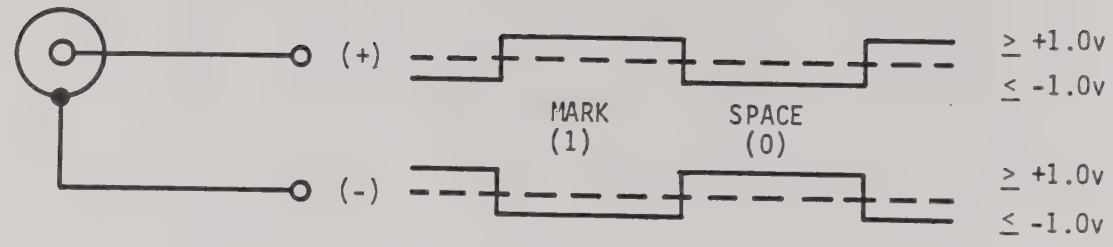
This section describes the relationship between the Lab Interface input and output signals and the FIREBERD rear panel test points.

RCV DATA/TX DATA

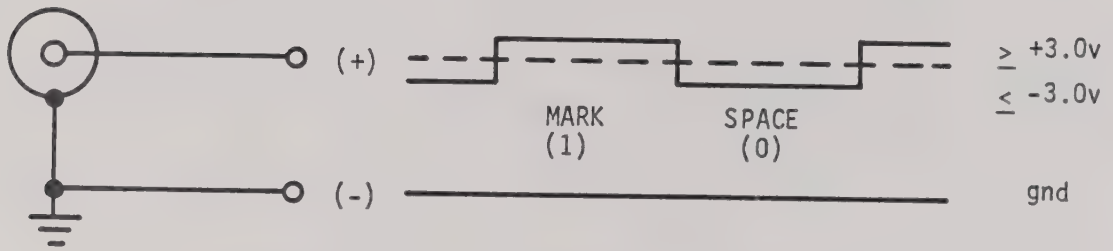
The signal level at this test point will be greater than 2.5 volts when the receive data at the Interface Adaptor is a Mark (logic 1), and will be less than 0.4 volts when the receive data is a Space (logic 0).

RCV TIMING/-

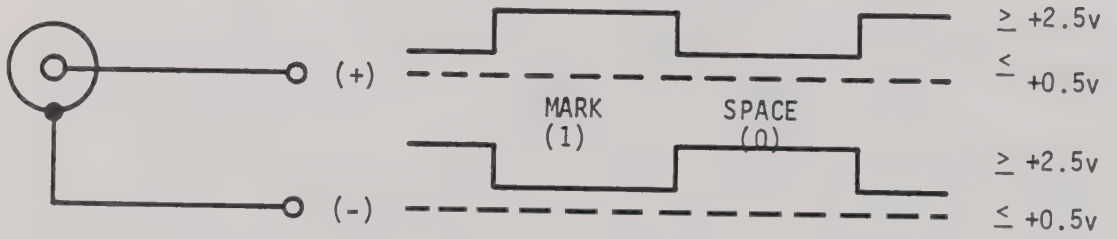
When the CLOCK PHASING switch is set to the " " or " " (rising edge valid receive data) position, the voltage at this test point will be less than 0.4 volts when the center conductor of the RCV CLK input is more positive than the outer conductor. The voltage at the test point will be greater than 2.5 volts when the center conductor is more negative than the outer conductor. If the CLOCK PHASING switch is set to the " " or " " positions, then the above relationships are reversed.



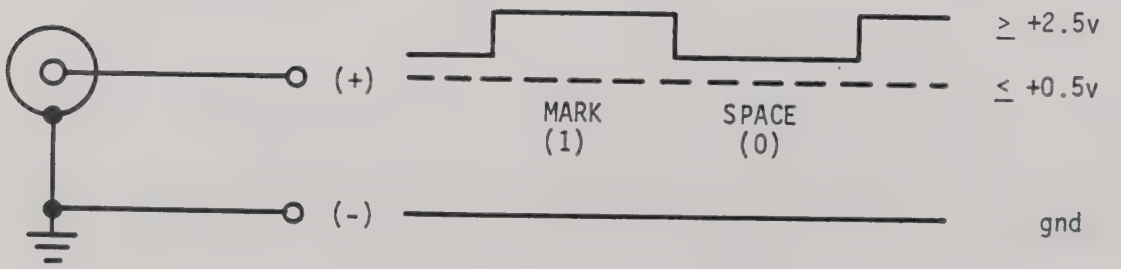
A. Bipolar Balanced



B. Bipolar Unbalanced

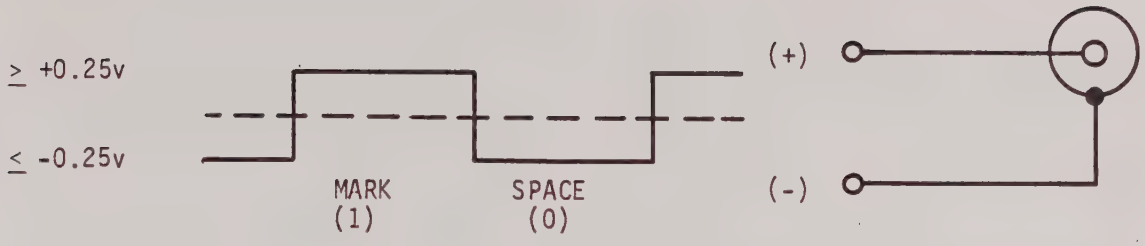


C. Unipolar Balanced

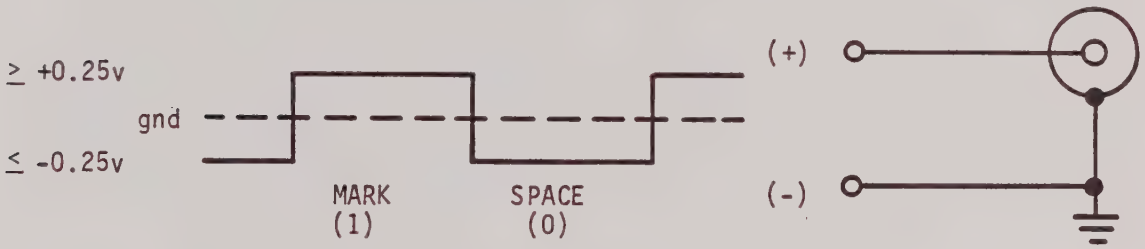


D. Unipolar Unbalanced

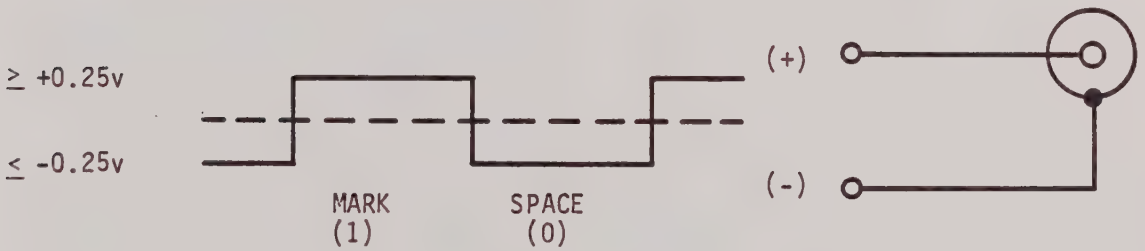
Figure 7-18
Selectable Operating Modes
Transmit Data and Clock Outputs



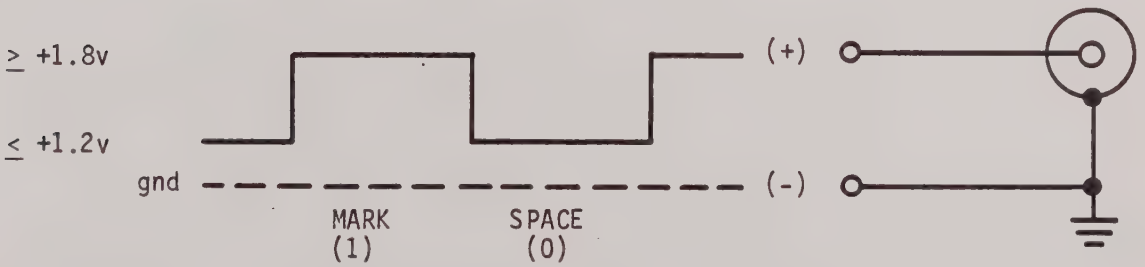
A. Bipolar Balanced (Differential voltage)



B. Bipolar Unbalanced



C. Unipolar Balanced (differential voltage)



D. Unipolar Unbalanced

Figure 7-19
Selectable Operating Modes
Minimum Required Input Levels

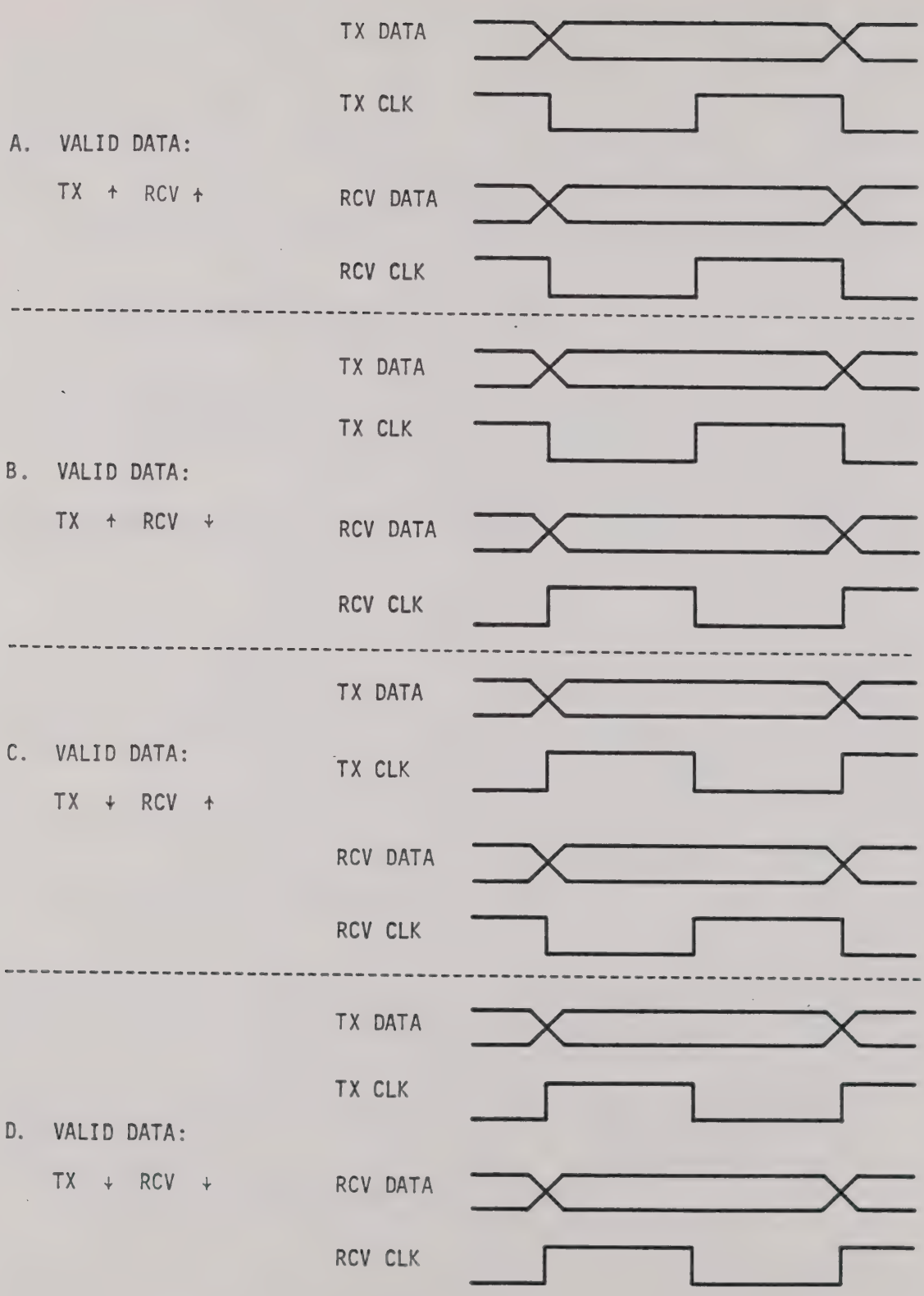


Figure 7-20
Clock Phasing Selections

TX DATA/RCV DATA

The signal at this test point will be greater than 2.5 volts when the transmit data is a Mark (logic 1) and will be less than 0.4 volts when the transmit data is a Space (logic 0).

TERM TIMING/RCV TIMING

The signal at this test point will be less than 0.4 volts when the center conductor of the TX CLK output is more positive than the outer conductor. The voltage at this test point will be greater than 2.5 volts when the center conductor is more negative than the outer conductor. Use of the CLOCK PHASING switch will not affect this relationship.

7.13.5 Applications Information

The following information is provided to aid in using the Lab Interface Adaptor to best advantage.

When operating at a high bit rate or when driving long cables, it is recommended that a terminating impedance be placed at the receiving end. The Lab Interface line drivers are low impedance drivers and can operate into any load down to 50 ohms. The terminating impedance will serve to reduce ringing and cable crosstalk.

When supplying the Lab Interface with an external clock input, note that the external clock signal must be in the same mode (e.g. Unipolar Unbalanced) as the transmit and receive data and clock signals.

The transmit data and clock outputs are high level (greater than 19 dBm into 50 ohms) and caution should be used when connecting to sensitive equipment.

When operating in the UNIPOLAR UNBALANCED mode with the INPUT IMPEDANCE switch set to 8K OHMS, the transmit and receive data and clock signals can be directly connected to any TTL family circuits. The Lab Interface inputs and outputs are compatible with all TTL families (e.g. Schottky TTL, LS TTL).

When operating in the UNIPOLAR BALANCED mode with the INPUT IMPEDANCE switch set to either 8K OHMS or 100 OHMS and with the CLOCK PHASING switch set to "↓↓", the Lab Interface should be functionally compatible with RS-422A systems.*

When operating in the BIPOLAR UNBALANCED mode with the INPUT IMPEDANCE switch set to 8K OHMS and with the CLOCK PHASING switch set to "↓↓", the Lab Interface should be functionally compatible with RS-232C, RS-423A, or Military Standard 188-114 bipolar unbalanced systems.

When operating in the BIPOLAR BALANCED mode with the INPUT IMPEDANCE switch set for 100 OHMS and the CLOCK PHASING switch set to "↓↓", the Lab Interface should be functionally compatible with Military Standard Mil-188-114 bipolar balanced, and with a pad on the outputs, V.35 systems.*

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*Full compliance with the mentioned system parameters is not guaranteed.

7.13.6 Specifications

OUTPUT LEVELS:

Bipolar Balanced:	± 2.0 volts minimum differential voltage (+19.0 dBm minimum into 50 ohms) (+17.3 dBm minimum into 75 ohms)
Bipolar Unbalanced:	± 3.0 volts d.c. minimum (+22.6 dBm minimum into 50 ohms) (+20.8 dBm minimum into 75 ohms)
Unipolar Balanced:	± 2.0 volts minimum differential voltage (+19.0 dBm minimum into 50 ohms) (+17.3 dBm minimum into 75 ohms)
Unipolar Unbalanced:	+2.5 volts d.c. minimum Mark (logic 1) +0.5 volts d.c. maximum Space (logic 0)

INPUT LEVELS:

Bipolar Balanced:	± 0.25 volts minimum differential voltage (+1.0 dBm @ 50 ohms; - 0.5 dBm @ 75 ohms ±12.0 volts dc maximum with respect to FIREBERD ground
Bipolar Unbalanced:	+0.25 volts d.c. minimum Mark (logic 1) -0.25 volts d.c. minimum Space (logic 0) (+1.0 dBm @ 50 ohms; - 0.5 dBm @ 75 ohms)
Unipolar Balanced:	± 0.25 volts minimum differential voltage (+1.0 dBm @ 50 ohms; - 0.5 dBm @ 75 ohms) ± 12.0 volts d.c. maximum with respect to FIREBERD ground

Unipolar Unbalanced:	+1.8 volts d.c. minimum Mark (logic 1)
	+1.2 volts d.c. maximum Space (logic 0)

MAXIMUM INPUT LEVELS:

The following voltage levels are not to be exceeded at any time (differential voltage for Balanced operation, volts d.c. for Unbalanced operation):

50 ohms	± 3.3 volts (23.4 dBm)
75 ohms	± 4.0 volts (23.3 dBm)
100 ohms	± 4.7 volts (23.4 dBm)
8K ohms	± 15.0 volts

7.14 T1 INTERFACE ADAPTOR MODULE (Model 40365)

7.14.1 Introduction

The T1 Interface Adaptor allows the FIREBERD 1500, 1500A, 2000, and 2000-1 test sets to test PCM communications systems that use the Bell System T1 (DS-1) 1.544 Mb/s Digital Channel Service and similar systems. The T1 signals are serial, differential return-to-zero (RZ) pulses with alternate mark inversion (AMI) coding.

In addition to making the conversions between the TTL levels of the FIREBERD and the T1 signals, the T1 Interface Adaptor has the following capabilities:

* It accepts low-level degraded signals, regenerates the data, and recovers the clock timing from the data.

* The FIREBERD's $2^{20}-1$ pseudorandom pattern can be modified to conform to the Bell System quasi-random signal source (QRSS) pattern having no more than 14 consecutive zeros.

* Bipolar Parity Violations (BPV's) in the received data can be detected and converted to bit errors for processing by the FIREBERD.

* Bipolar Parity Violations (BPV's) can be inserted in live traffic at various error rates for Automatic Protection Switching (APS) testing.

7.14.2 Operating Modes

7.14.2.1 Bit Error Detection ("NORM" switch setting)

In this mode, bipolar violations are ignored and the received T1 data are sent to the FIREBERD for bit error analysis.

7.14.2.2 Bipolar Parity Violation Detection ("BPV" setting)

The interface adaptor includes circuitry for detecting two successive ones with the same polarity. When this mode of operation is being used, the output of the FIREBERD is looped back to its input by the Interface Adaptor and a bit error is inserted in the looped-back pattern for each bipolar violation in the incoming signal. The output of the T1 Interface Adaptor is the pattern selected on the FIREBERD front panel. A fail-safe circuit automatically breaks the loop-back path when no T1 input signal is detected.

7.14.2.3 APS Testing ("APS" switch setting)

Bipolar parity violations may be inserted in live traffic for testing Automatic Protection Switching in T1 systems. The input of the interface adaptor is re-transmitted with BPV's inserted in the transmitted data. BPV's are spaced as evenly as possible for each of the switch-selected rates.

In the APS Testing mode, the output of the FIREBERD is looped back to its input by the Interface Adaptor and a bit error is inserted in the looped-back pattern for each inserted BPV. This provides a means of verifying the error rates as they are generated.

A fail-safe circuit automatically breaks the loop-back path when no T1 input signal is detected.

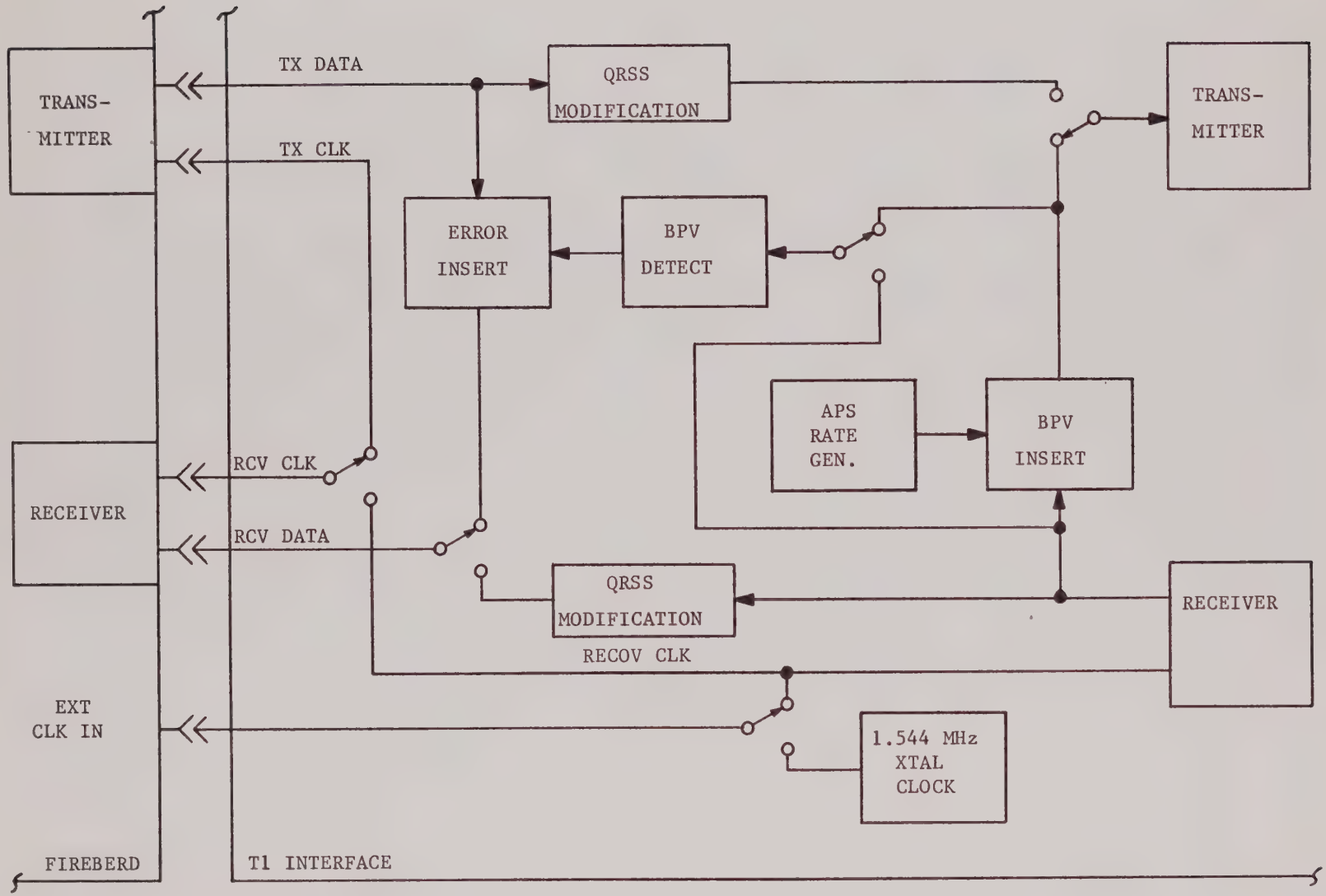

FIGURE 7-21

BLOCK DIAGRAM

T1 INTERFACE ADAPTOR

7.14.3 Loop Test

7.14.3.1 Bit Error Detection Mode ("NORM" switch setting)

The Interface Adaptor includes a relay which is activated by the FIREBERD front panel LOOP TEST switch. In the "TEST" position, the data line driver is connected to the data line receiver. This provides a quick verification of the operation of the FIREBERD and its interface in the Bit Error Detection mode. The input and output connectors need not be removed during the test because complete isolation is provided by the relay when testing. Note that a source of transmit timing must be provided for Loop Testing and the "RECOV (LOOP)" position of the interface adaptor TX Timing switch should not be used.

7.14.3.2 Bipolar Parity Violation Detection Mode ("BPV" setting)

When the combination of "LOOP TEST" and "BPV" switch positions is selected, operation of the FIREBERD and T1 Interface Adaptor should appear the same as when the "LOOP TEST" and "NORM" positions are selected. Note that the ability of the BPV detection circuitry to detect BPV's is not checked in this mode, as no BPV's are generated. Malfunctions of the BPV detection circuitry are likely to show up, however, due to false error detection. A more complete check of the BPV detection circuitry is provided by operating the interface in the APS mode setting and providing an external source of T1 signals. In the APS mode, the insertion of bipolar violations is checked using all the BPV detection circuitry except the receiver. The "RECOV (LOOP)" position of the interface adaptor TX TIMING switch should not be used in this mode.

7.14.3.3 APS Testing Mode ("APS" switch setting)

The Interface Adaptor will not function when the combination of "LOOP TEST" and "APS" switch settings is selected. This is because the received data is re-transmitted in APS mode, but the transmitted data is looped back to the receiver by the LOOP TEST switch.

7.14.4 FIREBERD Indicators

7.14.4.1 Received Data LED's

When the T1 Interface Adaptor is used with a Model 1500 or 1500A FIREBERD, an input signal consisting of a continuous string of ones will cause only the MARK LED to light. Absence of an input signal will cause only the SPACE LED to light. When the T1 Interface Adaptor is used with a Model 2000 or 2000-1 FIREBERD, any input signal containing data transitions will cause the Data Activity LED to light.

7.14.4.2 RCV CLK ACTIVITY LED

The RCV CLK ACTIVITY LED will be lit whenever a normal T1 signal is being received. Absence of an input signal will extinguish the LED.

7.14.5 Transmit Clock

There are four clock sources available for use as the source of transmit timing:

* An externally supplied signal input through the FIREBERD's rear panel BNC connector

* An oscillator installed in the FIREBERD as FA, FB, etc.

* A crystal oscillator located on the Interface Adaptor

* The clock recovered from the incoming T1 data

The latter two sources are selected by placing the FIREBERD GENERATOR CLOCK or CLOCK SELECT switch in the "EXT" or "EXT I/F" position and placing the TX TIMING switch in either the "XTAL" or "RECOV (LOOP)" position.

7.14.6 Switches

The following switches are provided on the panel of the Interface Adaptor:

7.14.6.1 MODE

A 3-position toggle switch that selects Bit Error Detection ("NORM"), Bipolar Parity Violation Detection ("BPV"), or APS Test ("APS") operating mode.

7.14.6.2 APS RATES

This pair of concentric rotary switches selects the error rates for APS testing. The center knob is the sequence control and the outer knob is the range control. No errors are inserted when the sequence switch is in the "START" position. The error rates that can be generated are listed in Table 7-14. The same rates are given as powers of 10 in Table 7-15.

Table 7-14. APS Error Rates

Sequence	STD/ 51A	Range				
		1 E-3	1 E-4	1 E-5	1 E-6	1 E-7
Start	STD	0	0	0	0	0
No Transfer	STD	5.0 E-4	5.0 E-5	5.0 E-6	3.2 E-7	5.0 E-8
Transfer	STD	2.0 E-3	2.0 E-4	2.0 E-5	1.3 E-6	2.0 E-7
No Restore	STD	5.0 E-4	5.0 E-5	5.0 E-6	3.2 E-7	5.0 E-8
Restore	STD	3.2 E-5	3.2 E-6	3.2 E-7	2.0 E-8	3.2 E-9
Start	51A	N/A	0	0	0	0
No Transfer	51A	N/A	5.0 E-5	5.0 E-6	5.0 E-7	5.0 E-8
Transfer	51a	N/A	2.0 E-4	2.0 E-5	2.0 E-6	2.0 E-7
No Restore	51A	N/A	1.3 E-4	1.3 E-5	1.3 E-6	1.3 E-7
Restore	51A	N/A	5.0 E-5	5.0 E-6	5.0 E-7	5.0 E-8

Table 7-15. APS Error Rates As Powers Of Ten

Sequence	STD/ 51A	Range				
		1 E-3	1 E-4	1 E-5	1 E-6	1 E-7
Start	STD	0	0	0	0	0
No Transfer	STD	10 E-3.3	10 E-4.3	10 E-5.3	10 E-6.5	10 E-7.3
Transfer	STD	10 E-2.7	10 E-3.7	10 E-4.7	10 E-5.9	10 E-6.7
No Restore	STD	10 E-3.3	10 E-4.3	10 E-5.3	10 E-6.5	10 E-7.3
Restore	STD	10 E-4.5	10 E-5.5	10 E-6.5	10 E-7.7	10 E-8.5
Start	51A	N/A	0	0	0	0
No Transfer	51A	N/A	10 E-4.3	10 E-5.3	10 E-6.3	10 E-7.3
Transfer	51A	N/A	10 E-3.7	10 E-4.7	10 E-5.7	10 E-6.7
No Restore	51A	N/A	10 E-3.9	10 E-4.9	10 E-5.9	10 E-6.9
Restore	51A	N/A	10 E-4.3	10 E-5.3	10 E-6.3	10 E-7.3

7.14.6.3 STD/51A

This toggle switch selects "STD" (for Bell System hysteresis-type switching equipment) or "51A" (for Culbertson and similar non-hysteresis switching equipment) BPV insertion characteristics for APS testing.

7.14.6.4 TX Timing

This toggle switch selects the source of transmit timing when the FIREBERD Generator Clock or Clock Select switch is in the "EXT" or "EXT I/F" position. The "XTAL" position selects the crystal oscillator on the Interface Adaptor; the "RECOV (LOOP)" position selects the clock recovered from the incoming T1 data. Note that the "RECOV (LOOP)" position should not be used with the FIREBERD in a Loop Test mode.

7.14.6.5 TERM/BRIDGE

This toggle switch selects input impedances of 100 or greater than 1000 ohms, respectively, for terminating or bridging a line. This switch should always be in the "TERM" position except when bridging a terminated line.

7.14.7 MOD/DIS Pluggable Jumper

The black plastic cover must be removed to gain access to this pluggable jumper located on the large circuit board. The Interface Adaptor is shipped with the small square plastic jumper block in the position marked "MOD." In this position it modifies the transmitted signal to prevent more than 14 consecutive zeros. This modification affects primarily the $2^{20}-1$ pattern. When used with the FIREBERD 1500A, if the $2^{15}-1$ pattern is selected and the DATA switch is placed in the "INV" position, one zero per pattern repetition will be replaced by a one. A Space pattern is also converted to a Mark pattern.

When the FIREBERD is set for one of the modified patterns and is in sync with the received signal, a bit is inverted in the received signal at each of the positions where a zero was changed to a one in the transmitted pattern.

When the Pluggable Jumper is in the "DIS" position, the transmitted and received signals are not modified.

NOTE

Compatibility problems can arise when operating with another test set. These problems are all related to pattern modification to limit the number of consecutive zeros to 14.

As long as the pluggable jumper is in the "MOD" position, there will be no problem in operating with test sets used exclusively for T1 testing, such as the Bowmar Model 273A, which only transmit the Bell System QRSS pattern with the number of zeros limited to 14. If, however, the T1 Interface Adaptor has its pluggable jumper in the "DIS" position, disabling modification of the 2^{20}-1 pattern, each test set will see errors in the transmission of the other (2.95 E-5 BER).

To achieve compatibility with a FIREBERD equipped with a Model 40151 DS1 Interface Adaptor using the 2^{20}-1 pattern, move the pluggable jumper to the "DIS" position. If it is not necessary to use the unmodified 2^{20}-1 pattern, no problems should be encountered as long as you do not use the 2^{20}-1 or Space patterns when the pluggable jumper is in the "MOD" position.

Two FIREBERDS equipped with T1 Interface Adaptors will also require the precautions described above if one of the T1 Interface Adaptors has its pluggable jumper set different from the other.

7.14.8 Connectors

Two WECO 310 jacks are provided for T1 line output and input. The jack sleeve is connected to ground; the differential signal appears across tip and ring. An optional cable is available for mating with a 15-pin "D" connector.

7.14.9 Specifications

7.14.9.1 Output

* Output Pulse Amplitude: ± 3 ± 0.3v into 100 ohms with maximum unbalance of ± 0.15v

* Output Pulse Width: 324 ± 30 ns (half amplitude) with maximum unbalance of ± 15 ns

* Rise and Fall Times: 50 ± 25 ns (10 to 90%)

* Trailing Edge Overshoot: 10 to 30% of pulse height with decay to 10% or less of base line-to-peak value within 400 ns

7.14.9.2 Input

* Input Threshold: The T1 Interface will function with a ± 3v input signal with up to 24 dB of cable attenuation

* Input Impedance: Terminating: 100 ohms ± 5%
  Bridging: > 1000 ohms

* Clock Recovery: The recovered clock shall remain in synchronization with the received data at a minimum "1"s density of 14 "0"s followed by 2 "1"s.

7.14.9.3 Crystal Oscillator

* Frequency: 1.54400 MHz

* Accuracy and Stability: ± 35 ppm, 0 to 50 deg. C

* Drift: 5 ppm per year typical

7.14.10 Operation

Table 7-16 summarizes the control settings for quick reference.

Table 7-16. Summary Of Control Settings

Function	MODE	51A/STD	APS TEST SEQUENCE	RANGE	TX TIMING	BRIDGE/TERM
Bit Error Detection	NORM	N/C*	N/C	N/C	XTAL or RECOV	BRIDGE** or TERM
Bipolar Parity Violation Detection	BPV	N/C	N/C	N/C	RECOV	BRIDGE** or TERM
Automatic Protection Switching	APS	---- as appropriate ----			RECOV	TERM

* N/C = don't care
** BRIDGE should only be used when bridging a terminated line.

SECTION 8
OPTIONS AND ACCESSORIES

8.1 INTRODUCTION

This section describes some of the options and accessories available for use with the FIREBERD. Information is provided on the Printer, Data Logger, Interface Switching Unit, Rack Mount, Shipping Case, Soft Carrying Case, Metal Case option, Metal Case Rack Mounts, and Optional Oscillators. Information is not provided on the Interface Modules since these are covered in Section 7 of this manual.

8.2 PR-2000 THERMAL PRINTER

The PR-2000 is a quiet, non-impact, alphanumeric thermal printer. It is capable of printing the full printable ASCII character set with up to 20 characters per line. The characters are input in a serial asynchronous format with Start, Stop, and Parity bits. This small portable unit may be operated on a bench top or rack mounted along with the FIREBERD in the optional RM-1500A or RMP-M2000 Rack Mount units. A cable is included with each printer allowing it to directly interface with the FIREBERD RS-232 Printer Interface at 2400 baud. For more information on the PR-2000 Thermal Printer, see the PR-2000 Operating Manual.

8.3 DL-2000 DATA LOGGER

The Data Logger is a self-contained, self-powered, incremental cassette recording and playback instrument. This unit allows up to 72,000 bytes of data from the FIREBERD RS-232 printer interface to be recorded on a standard digital cassette tape. The recorded tape provides a permanent test record and a convenient method of inputing test data directly into a computer for analysis.

A cable provided with the unit allows the recording to occur with or without a simultaneous printout on a PR-2000 thermal printer.

Playback is provided through the RS-232 Interface at rates of 110 or 300 Baud with pauses allowable after each character. Playback at 1200 Baud is also possible provided that transmission is not interrupted until the entire file has been read.

The DL-2000 may be used on a bench top or rack mounted in a standard 19" rack. The unit occupies 5 1/4" of vertical rack space.

For more information on the DL-2000, refer to the DL-2000 Operating Manual.

8.4 ISU-2000 INTERFACE SWITCHING UNIT

The Interface Switching Unit (ISU) allows the user to change the FIREBERD Interface Adaptor without physically removing and inserting the Interface Adaptors. The ISU is a rack-mountable device capable of supporting up to four Interface Adaptors and electronically selecting one Interface Adaptor for use with the FIREBERD.

Intended to be rack mounted either directly above or directly below the FIREBERD, the Interface Switching Unit is connected to the FIREBERD via a ribbon cable attached to a special Interface Adaptor (included). Switching between Interface Adaptors can be accomplished via pushbutton switches mounted on the ISU or remotely via contact closures. Indicators are provided on the ISU indicating which Interface Adaptor is on line and whether the unit is under local or remote control.

The Interface Switching Unit will accommodate any of the FIREBERD Interface adaptors and can be mounted with the Adaptor facing the front of the rack (front access) or the rear of the rack (rear access). A BNC connector is

mounted facing the front of the rack for the application of an external clock signal to the FIREBERD. The ISU can operate at 100/120/220/240 volts AC (50/60 Hz) and occupies 5 1/4" of rack height. For additional information on the Interface Switching Unit, see the ISU-2000 Operating Manual.

8.5 RM-1500A RACK MOUNT

8.5.1 General Information

The RM-1500A allows the Standard FIREBERD 2000 (plastic case) and the PR-2000 Thermal Printer to be mounted in a standard 19" equipment rack. The assembly requires 7" of vertical rack space. The Rack Mount provides a power switch for the Thermal Printer and an AC receptacle to provide AC power to both the FIREBERD and PR-2000 Thermal Printer.

WARNING

To minimize shock hazard, the Rack Mount chassis must be connected to an electrical ground. The Rack Mount is equipped with a three-conductor AC power cable. The power cable must either be plugged into an approved three-contact electrical outlet or used with a three-contact to two-contact adaptor with grounding wire (green) firmly connected to an electrical ground (safety ground) at the power outlet.

8.5.2 Installation Instructions

The following sections provide instructions for mounting the FIREBERD and PR-2000 Printer in the RM-1500A Rack Mount. If the FIREBERD has a swing-around handle, this handle must be removed before mounting into the Rack Mount. If the FIREBERD does not have a handle, proceed directly to the

assembly instructions. If the FIREBERD does have a handle, the user may return the FIREBERD to TTC for handle removal or use the following handle removal instructions to remove the handle.

FIREBERD HANDLE REMOVAL

1. Disconnect the AC power cord from the FIREBERD.

2. Remove the left and right knurl nuts and the small springs on each side and spring the side arms enough to remove the handle assembly.

3. Lay the instrument on its top and remove the feet and four long screws.

4. Return the instrument to its "right side up" position and carefully remove the top shell.

5. Remove the hex screw and side ratchet assembly from each side of the unit.

6. Make sure the Receiver (middle) PC board is in the third slot from the top in the card slides and remount the top shell making sure it "seats" in the side expanders and front and rear panels.

7. Lay the instrument on its top and reassemble the feet and four long screws. Do not overtighten the screws.

8. Return the instrument to its "right side up" position. The FIREBERD is now ready for its rack mount assembly.

ASSEMBLY INSTRUCTIONS

1. Install the printer as follows:*
   a. Insert the PR-2000 through the Rack Mount Panel from the front.
   b. Unlatch and slide the printer mechanism forward, exposing the printer mounting ears. Install four #4 x 3/16" lg. pan head screws into the holes of the mounting ears then return the printer mechanism to its operating position (closed).
   c. Install the printer support bracket at the rear of the printer by removing the two #3 screws at the top, rear of the PR-2000. Attach the support bracket to the printer and chassis using four #4-40 x 3/16" lg. screws and lock washers.

2. Install FIREBERD as follows:
   a. Make sure the FIREBERD does not have the handle or side handle ratchet installed. The sides of the FIREBERD must be free of all handle components in order to fit into the rack adaptor.
   b. Place the FIREBERD on the shelf, front panel facing front, and carefully manipulate the front of the case through the opening. It should protrude through the front panel about 1/4 inch.
   c. Lift the rear of the FIREBERD and insert the two 1/4" hex x 3/16" lg. standoffs in the rear feet and align with two holes in the shelf. Install two #6 x 3/16" lg. screws and two lock washers through the bottom of the shelf into the standoffs.

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*If a printer is not to be installed into the Rack Mount unit, a blank-off plate is available to cover the Printer Mounting hole.

d. Install the two "Z" hold-down brackets at the rear of the instrument using the #4 hardware provided with the rack adaptor.

e. Plug the FIREBERD and the printer into the 115 VAC receptacle. The printer should be plugged into the receptacle that is controlled by the front panel switch.

f. Fold and store excess FIREBERD and printer line cord under the printer. The bracket is designed to allow cable storage.

3. Connect the cable supplied with the printer from the 25 pin "D" type connector on the rear of the printer to the RS-232 printer connector on the FIREBERD.

4. The RM-1500A unit should now be ready for rack installation. The unit will mount in a rack by its front panel without further angle brackets or supports.

8.6 SHIPPING CASE (MODEL 10176)

The shipping case holds a standard FIREBERD (plastic case), PR-2000 Thermal Printer, 5 Interface Modules, accessory cables and this manual. The rigid ABS molded case has a foam padded interior with cavities to hold the FIREBERD and its accessories. The case is rugged and water resistant, has stainless steel draw latches, and a molded handle. Case dimensions are 26 1/2" x 19" x 11 1/2".

8.7 SOFT CARRYING CASE (MODEL 10170)

The FIREBERD soft side carrying case is constructed of canvas with dense foam inserts surrounding all sides, top and bottom. The dimensions are 19 1/2" wide x 9 1/2" deep x 16 1/8" high. The case is navy blue and has an I.D. pocket on the top cover. The top cover is hinged and secured with Velcro fasteners. The case is carried by a handle that supports across the bottom and up both sides.

The carrying case holds one Standard FIREBERD (plastic case), one Printer, one Manual, and three Interface Adaptors in addition to the associated cables and line cords. Empty, the case weighs 6 1/4 lbs.

8.8 FIREBERD M2000 (METAL CASE OPTION)

The FIREBERD M2000 is the ruggedized version of the standard FIREBERD 2000. Performance characteristics, front and rear panel formats, and internal electronic sub assemblies are identical.

The FIREBERD M2000 housing is of metal construction and quite rugged. The unit comes with front and rear latch-on covers. With the covers in place, the instrument is completely protected and can be carried and handled like a piece of luggage. In addition to protection, the covers store two extra Interface Adaptor Modules and the line cord.

The FIREBERD M2000 may be operated in a vertical or horizontal position. In the horizontal position, a bale flips up to elevate the front panel to a convenient viewing angle. When no bench space is available, the extra length rear handles enable the unit to operate in a vertical position, on the floor, with the Interface Adaptor Module and cable installed.

The FIREBERD M2000 is 7.6" high (including the feet), 14.2" wide and 16.2" deep (including the covers). With covers, the unit weighs 18 lbs.

8.9 FIREBERD M2000 RACK MOUNTS (MODELS RM-M2000 and RMP-M2000)

8.9.1 General Information

The RM-M2000 consists of a pair of side flanges which allow the FIREBERD M2000 to be rack mounted as a standard 19" wide x 7" high unit.

The RMP-M2000 consists of a pair of side flanges which allow the FIREBERD M2000 to be rack mounted as a standard 19" wide x 7" high unit. The right side flange is capable of excepting a vertical mount PR2000 Printer or an optional blank off plate.

When the FIREBERD M2000 is equipped with the RM-M2000 or RMP-M2000 rack mount kit, the following items are removed and shipped as loose items: front and rear covers (1 each), side feet (4 each), rear bottom feet (2 each), bail assembly (1), and front and rear catch strikes (4 each).

8.9.2 Installation Instructions

To install (retrofit) the RM-M2000 or RMP-M2000 rack mount kit, proceed as follows:

1. Remove front and rear covers.
2. Remove 4 feet from side of unit.
3. Remove the 4 catch strikes at the front and rear side frames.
4. Remove the bail assembly and two rear feet from the bottom of the unit.
5. The RM-M2000 rack mount kit is installed by assemblying the 2 flanges to the left and right front corner of the unit using hardware provided (six screws per flange). The RMP-M2000 is installed with the small flange on the left (when facing unit) and the large flange on the right. The printer is not installed until after the right flange is in place and the switch housing is loosened (do not unwire) to access the flange mounting screw. Each flange is assembled using six screws.

8.10 OPTIONAL CLOCKS

Up to four user specified frequencies may be provided in the FIREBERD unit. These clocks are selected by the FA, FB, FC, and FD positions of the GENERATOR CLOCK switch. Each oscillator is available at frequencies ranging from 100 Hz to 10 MHz.

The options are as follows:

Option 003	One Additional Internal Clock Rate
Option 004	Two Additional Internal Clock Rates
Option 005	Three Additional Internal Clock Rates
Option 006	Four Additional Internal Clock Rates

Each oscillator provides frequencies which are accurate to within $\pm$ 1 ppm at 25° C, $\pm$ 5 ppm Stability from 0° to 40° C, and 5 ppm typical aging per year. The frequency of any of the oscillators may be periodically aligned to within $\pm$ 1 ppm by TTC authorized personnel. Refer to the OSC OPTION label on the rear of FIREBERD for the optional oscillator positions.

SECTION 9
MAINTENANCE AND SERVICE

9.1 IN CASE OF DIFFICULTY

If the unit fails to operate and no front or rear panel indicators illuminate, check the following:

AC power cord and AC supply
AC fuse and fuse size

If some indicators light but the unit fails to operate, verify that the Interface Adaptor Module in use is the correct type and properly inserted (turn off power before inserting or removing Interface Module). Check the interface cable and connections to the FIREBERD. Try substituting another Interface Module if one is available.

Follow the Self Test Procedure in Section 3 as an aid to localizing the problem. If the unit cannot be made to operate properly, refer to the following sections for service information.

9.2 WARRANTY POLICY

All equipment manufactured by Telecommunications Techniques Corporation (TTC) is warranted against defects in material and workmanship. Defective equipment will be repaired or replaced (at our option) at no charge for a period of one year after original receipt by the customer.

Liability under this warranty extends only to the replacement value of the equipment. This warranty is void if:

1. Equipment has been altered or repaired without specific authorization by TTC.

2. Equipment is installed or operated other than in accordance with instructions contained in TTC literature and operating manuals.

After expiration of the warranty period, equipment must be returned prepaid to TTC for repair. The customer will be billed for parts cost plus the standard labor rates in effect at the time of repair.

No other warranty is expressed or implied. TTC is not liable for consequential damages.

9.3 IN-WARRANTY SERVICE

Units in warranty should be returned to the factory with shipping prepaid, and should be packed and shipped in accordance with the instructions contained in Section 9.5 of this manual. Defective units will be repaired or replaced (at our option) depending on severity of defect. Prior to returning any equipment, the customer should obtain a Return Authorization (RA) number by contacting TTC. The customer should enclose a description of the problem along with his name, address and telephone number, the serial number(s) of the equipment returned, and the RA number. Normal repair time is five working days.

Upon completing repairs, the unit will be tested to applicable specifications and burned-in for at least 24 hours. Following burn-in, it will be returned to the customer with shipping prepaid. A brief description of the work performed and the materials used will be provided on the Equipment Repair Report which is furnished with the returned equipment.

9.4 OUT-OF-WARRANTY SERVICE

The procedure for repairing out-of-warranty equipment is the same as that used for units still in warranty. There is, however, a minimum charge of $75.00 applied to each request for out-of-warranty service. The $75.00 minimum charge guarantees the customer an estimate of the repair costs and is used as credit against actual materials and labor costs should the equipment be repaired. The customer will be required to furnish a purchase order number before repair work can be started. A description of the labor and materials used is provided in the Equipment Repair Report.

9.5 REPACKAGING FOR SHIPMENT

If the instrument is to be shipped to TTC for repair, attach a tag showing owner, address and phone number, complete instrument serial number, and a description of the service requested. Use the original shipping container and material if possible. If the original container is not available, carefully pack the unit so it will not be damaged in transit. TTC is not liable for any damage that may occur during shipping.

APPENDIX A

ABBREVIATIONS

APPENDIX A - ABBREVIATIONS

async	asynchronous
BER	bit error rate
blk	block
blk error	block error
bps	bits per second
clk	clock
CS	Clear To Send
CTS	Clear To Send
DCE	Data Communications Equipment
DM	Data Mode
DSR	Data Set Ready
DTE	Data Terminal Equipment
DTR	Data Terminal Ready
err	error
err sec	error sec
ext	external
gen	generator
Hz	Hertz
inv	invert
isoch	isochronous
I/F	interface
k	kilo (1000)
kHz	kilo Hertz
LED	light emitting diode
LL	Local Loopback
Mbps	million bits per second
MHz	mega Hertz
min	minute
MK	mark

pp	peak to peak
ppm	part per million
rcv	receive
RL	Remote Loopback
RLSD	Receive Line Signal Detect
RR	Receiver Ready
RS	Request To Send
RTS	Request To Send
sec	second
sp	space
sync	synchronous
TM	Test Mode
TR	Terminal Ready
TTC	Telecommunications Techniques Corporatio
Tx	transmit
v	volts

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